NAVAL HEALTH RESEARCH CENTER

NAVY LUNG DISEASE ASSESSMENT PROGRAM: FINAL REPORT

F. C. Garland
E. D. Gorham
K. Kaiser
W. D. Travis
J. A. Centeno
J. L. Abraham
F. Hasibuan

Report No. 04-06

Approved for public release; distribution unlimited.

NAVAL HEALTH RESEARCH CENTER
P. O. BOX 85122
SAN DIEGO, CA 92186-5122

BUREAU OF MEDICINE AND SURGERY (M2)
2300 E ST. NW
WASHINGTON, DC 20372-5300

NAVY LUNG DISEASE ASSESSMENT PROGRAM

FINAL REPORT

NAVAL HEALTH RESEARCH CENTER
SAN DIEGO, CALIFORNIA
AND
ARMED FORCES INSTITUTE OF PATHOLOGY
WASHINGTON, DC

February 18,2004

Navy Lung Disease Assessment Program: Final Report

Program Manager: Frank C. Garland, Ph.D.[1]

Contributing Authors: Edward D. Gorham, M.P.H., Ph.D.[1]; Kevin Kaiser, M.P.H.[2]; William D. Travis, M.D.[3]; Jose A. Centeno, Ph.D. [3]; Jerrold L. Abraham, M.D.[4]; Franky Hasibuan, M.P.H.[2]

[1]Naval Health Research Center, San Diego, CA

[2]GEO-CENTERS, INC., Clinton, MD 20735

[3]Armed Forces Institute of Pathology, Washington, DC 20306-6000

[4]Department of Pathology, Upstate Medical University, State University of New York, Syracuse, NY

Correspondence to: Dr. Frank Garland, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92186-5122. Code 02B, Telephone (619) 553-8480; fax (619) 524-9888; e-mail: garland@nhrc.navy.mil

This report was supported by the Navy Bureau of Medicine and Surgery, under Special Project number 60208. The views expressed in this report are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense (DoD), or U.S. Government. Approved for public release; distribution unlimited. This research has been conducted in compliance with all applicable federal regulations governing the protection of human subjects in research.

Table of Contents

EXECUTIVE SUMMARY

Background: In response to Congressional concerns that occupational lung disease may have been misdiagnosed among Navy personnel exposed to dusts aboard ship, the Navy Bureau of Medicine and Surgery established the Navy Lung Disease Assessment Program and designated the Naval Health Research Center (NHRC) as the Program Manager. NHRC established an External Scientific Advisory Committee to help design a research project to address the question of lung disease misdiagnosis. A Public Policy Advisory Committee was also established to answer public concerns. With concurrence of these 2 committees, research objectives were defined and 2 primary approaches were developed to examine the potential for lung disease misdiagnosis.

Approaches: Two epidemiological studies were undertaken that covered more than 10 million person-years of Navy service going back as far as 1965. These studies included detailed information on incidence of lung disease hospitalizations, Navy occupational history and history of ship assignment. Additionally, an effort was made to discover and retrieve any remaining stored pathological materials from Navy personnel who had a hospital diagnosis of pulmonary sarcoidosis and to analyze these specimens at two laboratories using state-of-the-art techniques for detecting foreign particulates in tissue samples.

Methods: The first epidemiological study was a 27-year historical prospective study that examined time trends in incidence rates of sarcoidosis and other lung diseases from 1975 to 2001. The second was a nested case-control study that specifically examined shipboard duty-station assignments and occupations in relation to subsequent hospitalization for sarcoidosis. In addition to the epidemiological studies, a pathology study was conducted that used pathology expertise provided by two advanced pathology laboratories, and a records search performed by the Veterans Administration. NHRC established collaborations with the Armed Forces Institute of Pathology (AFIP), the Veterans Administration (VA), and the Advanced Pathology Laboratory at the Upstate University of New York Medical Center at Syracuse (SUNY). NHRC identified 12 major Navy hospitals where 1,273 Navy servicemen received a diagnosis of sarcoidosis while on active duty. NHRC requested searches at these hospitals for any extant pathologic materials. Pathologic specimens (blocks or slides) were available from Navy hospitals and AFIP for 30 of the 1,273 individuals hospitalized. Additionally, NHRC provided VA with identifying information for 5,466,087 Navy servicemen on active duty between 1965 and 2000. VA identified 2,657 hospitalizations for chronic lung disease among these individuals after separation from service. AFIP searched its tissue repository and located specimens from 11 of these individuals. All candidate material was reviewed under a previously agreed-upon protocol at the AFIP for suitability for detailed analysis. Tissues from 32 subjects were selected for detailed evaluation at AFIP and the SUNY laboratory.

Epidemiologic Study Results: Both epidemiological studies found that race and occupational history were related to sarcoidosis risk. Blacks were approximately 7 times more likely to receive a diagnosis of sarcoidosis as whites. The cohort study found that black Ship's Servicemen had 2.3 times the expected incidence of sarcoidosis in comparison

with all black Navy enlisted personnel, and black Aviation Structural Mechanics specializing in structures had approximately twice the expected incidence. White Mess Management Specialists also had twice the expected incidence of sarcoidosis as other white Navy enlisted service members. The case-control study found elevated odds ratios in certain aviation and deck ratings where exposure to nonskid materials may have occurred. This study also found that sarcoidosis risk was increased in association with a history of service aboard aircraft carriers in men of both races. Both studies found a steep decline in risk of hospitalized sarcoidosis since the early 1970s, particularly among blacks. Results from the cohort study indicate that the decline in sarcoidosis incidence could not be accounted for by an increase in incidence of other pulmonary diseases.

Pathology Study Results: Useable specimens were obtained from 32 individuals, including 25 men with a history of active-duty enlisted service in the Navy. Although the overall yield of pathological specimens was low, light microscopic examination at the SUNY laboratory showed a modest, statistically nonsignificant increase in particulate content among people who had a history of assignment to an aircraft carrier (OR = 1.67, p = 0.70), according to an analysis based on all individuals with light microscopic data. This association did not appear to be present in a smaller analysis limited to those with a history of hospitalization for sarcoidosis (OR = 0.75, p = 0.55). AFIP data did not indicate an association in an analysis based on all individuals (OR = 0.55, p = 0.69), nor those with a history of hospitalization for sarcoidosis (OR = 0.75, p = 0.55). Neither laboratory found a statistically significant increase in birefringent particles (SUNY OR = 0.94, p = 1.00; AFIP OR = 0.38, p = 0.42). The SUNY laboratory found an increase in silica-like particles in people who had a history of service aboard an aircraft carrier (OR = 3.64, p = 0.31), according to an analysis based on all individuals, and OR = 5.67 (p = 0.47) based on an analysis of those with a history of hospitalization for sarcoidosis. The AFIP analyses did not evaluate silicates and silica separately by light microscopy. The types of particulates identified were for the most part the types found in individuals from the general population, with the exception of a few unusual particles. The levels of aluminum silicates and talc identified were less than those typically associated with pneumoconiosis, and none of the tissues that were examined contained evidence of silicotic nodules. Some cases appeared to have infectious diseases (mycobacterial or fungal infections). The metals that were present in increased levels included Fe, Ti, Al, and Cr. The metals that are most characteristic of non-skid paint are Al, Zr, Ti, W, and Co. The particulates identified may not be the cause, but rather a marker for some other agent that is the cause of the granulomas.

External Scientific Advisory Committee Conclusions: The External Scientific Advisory Committee concluded that the two epidemiological studies had identified an association between history of service aboard an aircraft carrier and history of service in particular Navy occupations, and an increased risk of a subsequent hospitalization for sarcoidosis. The Committee found that the epidemiological studies suggested three likely explanations that could not be distinguished by present information. One was that a number of cases of pneumoconiosis resulting from exposures associated with some types of Navy service had been misdiagnosed as sarcoidosis. Another was that there was a subset of the population with a heightened susceptibility to sarcoidosis that was activated by exposures associated with some types of Navy service. The third possibility was that these findings were a

matter of chance, but the committee believed this possibility to be an unlikely explanation, since the increased risk was identified among groups with exposures suspected of causing disease. Based on review of pathology results, the committee recognized a possible association between history of aircraft carrier assignment and presence of silica-like particles and presence of titanium and aluminum. The Committee noted that these results could document past exposures to a mixture of agents that might support the hypotheses of this study, but that these analytical results cannot prove causation. Determination of causation must rely on standard epidemiological criteria, such as correctness of temporal association and biological plausibility. The committee concluded that the epidemiological evidence was supportive of the hypothesis that environmental factors may have potentially contributed historically to risk of sarcoidosis in this population.

Public Policy Advisory Committee Recommendations: The Public Advisory Committee recommended establishment of an outreach program in which U.S. government officials would notify military personnel who have worked aboard ships and acquired a diagnosis of "sarcoidosis". They should be informed that U.S. government medical personnel would conduct free medical evaluations to better clarify their lung disease if they knew or suspected that they had been exposed to dusts, such as those generated by deck-grinding, while aboard ship, or if they had a history or symptoms of lung disease.

1.0 INTRODUCTION

The U.S. Congress directed the Secretary of the Navy to establish an occupational lung disease assessment program. This program was to determine if naval personnel who were diagnosed with sarcoidosis might have actually had another lung disease that was misdiagnosed as sarcoidosis, and whether sarcoidosis or other lung diseases could be attributable to exposures during service aboard Navy ships. Pulmonary sarcoidosis is a disease of unknown cause that is approximately six to eight times more common among blacks in the general population and among black Navy enlisted personnel compared with white Navy enlisted service members.

The major concern was that removal through grinding of nonskid coatings that had been used extensively on Navy ship decks and ramps was causing an unrecognized form of occupationally related fibrotic lung disease. Nonskid coatings are made with particulate matter consisting of aluminum, titanium, silica, aluminum silicates, talc, iron, barium sulfate, and fibrous glass. Among numerous occupational groups, seamen, airmen, and Navy boatswain's mates assigned to aircraft carriers may have had the greatest opportunity for close-range exposure to nonskid coatings. It is unknown to what degree members of these groups are at risk for occupational lung disease and whether they may be more likely to have received a sarcoidosis diagnosis than other occupational groups.

In response to the Congressional mandate, the Navy Bureau of Medicine and Surgery established the Navy Lung Disease Assessment Program (NLDAP) and designated the Naval Health Research Center (NHRC), San Diego, to manage the program. The NLDAP established collaborative relationships between NHRC, the Armed Forces Institute of Pathology (AFIP), the VA, the State University of New York, and other collaborators to design the study, conduct the research, interpret the results and provide recommendations.

The NLDAP chartered an External Scientific Advisory Committee of experts to help design a research project to address the question of misdiagnosis of other lung disease as sarcoidosis while making the best use of existing resources. A Public Policy Advisory Committee was also established to answer public concerns. With the concurrence of these 2 committees, the program reached a general consensus on study objectives and methodology. 2 primary study areas were defined: (1) epidemiology, and (2) pathology. A detailed proposal describing 2 epidemiological studies and a pathological review and analysis were developed. This proposal was reviewed by an independent outside peer-review organization, the American Institute of Biological Sciences.

The focus of the first epidemiological study was to determine the incidence rates of sarcoidosis and other lung diseases in active-duty Navy enlisted men, based on hospital discharge diagnoses, and evaluate indications of possible misdiagnosis based on time trends and relationships to the incidence of other lung diseases. The focus of the second epidemiological study was detection of possible associations between occupational and duty station assignment and a hospital diagnosis of sarcoidosis, while controlling for other known sarcoidosis risk factors. Both these epidemiological studies also evaluated the

effect of policy changes in radiographic screening for respiratory diseases over time and its effect on trends in sarcoidosis incidence and risk.

The focus of the pathological studies was to identify available tissue samples from historically diagnosed cases of sarcoidosis in active-duty Navy enlisted men and re-examine these specimens using new techniques that could identify the presence of minerals in tissue samples. This was a technology that did not exist at the time that these diagnoses were made and even now goes beyond the standard for the diagnosis of sarcoidosis or most pneumoconioses. The combined evidence from the epidemiological studies and the pathological review of tissue for mineral analysis would allow conclusions to be drawn concerning the likelihood of a misdiagnosis of sarcoidosis.

2.0 HISTORICAL PERSPECTIVE

Sarcoidosis is a multisystem granulomatous disease of unknown etiology. Its symptoms are highly variable and may involve any system, although over 90% of cases involve the lungs (National Heart, Lung, and Blood Institute, 1995). As many as one half of patients are asymptomatic, and many cases resolve spontaneously (National Heart, Lung, and Blood Institute, 1995). Lung abnormalities, such as thoracic lymphadenopathy found on x-ray and common respiratory symptoms such as cough and shortness of breath, are the most common presentation of sarcoidosis (Demos, 1996). In some patients, sarcoidosis appears for a period of 2-3 years, and in 10-15% of cases, patients may have it for many years or throughout life (World Sarcoidosis Society, 2000). There may be some permanent lung damage in 20-23% of cases, and the disease can be fatal in 5-10% of cases where either the granulomas or fibrosis seriously affect the function of a vital organ (National Heart, Lung, and Blood Institute, 1995).

Although a variety of environmental, occupational, infectious, and genetic risk factors have been studied, no single exposure has been found that accounts for the geographic, age, or racial distribution of sarcoidosis (Kajdasz, Lackland, Mohr, and Judson 2001). Sarcoidosis occurs in both sexes, all age groups, and all races. It is found most commonly among people 20-40 years old. The National Institutes of Health estimates that about 5 in 100,000 white people and about 40 in 100,000 black people have sarcoidosis. Once thought to be rare in North America, a large number of cases were identified in the mid-1940s during mass chest x-ray screening for the Armed Forces (National Heart, Lung, and Blood Institute, 1995). Epidemiological studies have documented a higher prevalence of sarcoidosis in the Southeast and rural areas of the United States, but few other risk factors have been identified (Kajdasz et al., 2001).

Due to the variability of symptoms and population groups in which sarcoidosis can occur, diagnosis may be difficult and involves ruling out alternative diseases with similar signs and symptoms. Although the identification of foreign bodies in granulomas is generally thought to exclude a diagnosis of sarcoidosis, a recent investigation using electron probe microanalysis found birefringent foreign bodies consisting of calcium, phosphorus, silicon, and aluminum in granulomatous skin lesions in some patients with cutaneous sarcoidosis.

The authors suggested that the foreign body may serve as an inciting stimulus for granuloma formation in some cases of sarcoidosis (Kim, Triffet, & Gibson, 2000). Jajosky conducted a study of the risk of sarcoidosis in naval personnel using data provided by the Navy (Jajosky, 1998). His findings suggested a possible relationship of sarcoidosis with assignment aboard aircraft carriers, and with nonskid paint deck-grinding operations. Also, Abraham and Panitz reported (2001) on dust-exposed Navy workers, such as those who had done work grinding or removing paint materials, who had a sarcoidosis diagnosis, and who were found to have dusts in their lung tissues after analysis using electron microscopy or other techniques. These studies lead to an appeal by Abraham and Panitz and Reverend Jerry Cochran to Congress to investigate possible missed cases of dust-induced lung disease among military personnel (House of Representatives, 2000; Jajosky, 2000). Navy, Veterans Administration, and Congressional concerns were raised that naval personnel diagnosed with sarcoidosis actually may have suffered from other lung diseases related to exposure to occupational hazards during their military service.

3.0 EPIDEMIOLOGICAL STUDIES

3.1 Epidemiological Study 1. Time Trends of Navy Lung Diseases and Occupational Associations

3.1.1 Introduction

The first epidemiological study conducted under the NLDAP was a cohort study of incidence rates of sarcoidosis and other lung diseases and consisted of a report titled "Trends and Occupational Associations in Incidence of Lung Disease in Navy Personnel: A 27-Year Historical Prospective Study, 1975-2001" (Appendix A). This section is based on that study.

3.1.2 Methods

This study used a historical prospective design. Information from military service records was extracted to determine incidence rates of hospitalized sarcoidosis among Navy enlisted men according to age, race, occupational specialty, and hospitalization date. Incident cases of sarcoidosis, pneumoconioses, and other lung diseases were identified using the Standard Inpatient Data Record (SIDR) database of admissions to DoD medical treatment facilities (MTFS). Detailed population data were available from 1975 to 2001 through the Defense Manpower Data Center (DMDC) in Monterey, CA, and Navy archival records. Age-specific incidence rates of first hospitalization for sarcoidosis, pneumoconioses, and other lung diseases were calculated according to race during the time period from 1975 to 2001. Race-specific standardized incidence ratios were used to compare age-adjusted hospitalized incidence rates in active-duty enlisted Navy men by occupation and race. Case ascertainment among active-duty Navy men included a broad range of lung disease diagnoses to accurately and completely assess time trends in incidence and evaluate the potential for shifts in diagnostic patterns over time. The cases from 1985 to 2001 were identified using the DoD Executive Information Decision System SDDR, which includes admissions to all military hospitals. An SIDR identifies diagnoses using codes from the

International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM; 2000). Earlier cases were obtained from the Career History Archival Medical and Personnel System (CHAMPS) that was created by and is maintained by NHRC. CHAMPS contains archival career and medical history data on all active-duty Navy enlisted service members from 1966 through the present.

Demographic and personnel information from other established military data sources was used to supplement the SIDR and validate personnel and demographic information. The main source for validation of career and demographic information among active-duty military personnel in this study was the Defense Enrollment Eligibility Reporting System (DEERS), which is the central source for personnel information from the DoD. This database is used to determine medical benefits eligibility, insurance, immunizations, and patient information. Records were merged into CHAMPS. This system creates a longitudinal record for each individual. Diagnoses that were ascertained are listed in Table 3.1.2.1. The epidemiological analyses included a race-specific time trend study of lung disease incidence and an incidence study according to occupational designation.

Table 3.1.2.1. Lung Diseases and ICD-9-CM Codes Used for Case Ascertainment

Sarcoidosis (Code 135)
Pneumoconioses (Codes 501-505)
Respiratory conditions due to chemical fumes and vapors (Code 506)
Emphysema and chronic bronchitis (Codes 491, 492)
Asthma (Code 493)

Demographic and service-related information for defining cohorts was obtained from DMDC. DMDC maintains detailed personnel records for all active-duty members of the armed forces, including demographic information such as date of birth and race, as well as service-related information including length of service, changes in duty assignments, occupational specialties and home of record. Information obtained for cases is listed in Table 3.1.2.2.

Table 3.1.2.2 Demographic and Service-Related Information Obtained

Social security number or service identification number
Name
Date of birth
Race (white, black, other)
Gender
Home of record
Date of accession to naval service
Duty station assignments and dates (Unit Identification Code, Onboard Activity Code)
Occupational history (Navy rate code)
Date of end of naval service

Type of discharge from the Navy (loss code)
For cases:
Hospital discharge diagnoses
Date of first hospitalization with a diagnosis of sarcoidosis
Name of MTF (hospital)

Statistical analysis. Incidence rates of first hospitalization for sarcoidosis, pneumoconioses, and other lung diseases among active-duty Navy enlisted men were calculated according to race (white, black, other). Person-years were used in analyses aggregated across years, and midyear population counts were used for time-trend analyses of annual incidence rates. Race-specific standardized incidence ratios using person-years were used to compare age-adjusted hospitalized incidence rates in active-duty Navy men by occupation and race (Fleiss, 1981). Age-specific sarcoidosis incidence rates for all Navy enlisted men were applied to the occupation-specific populations at risk stratified by race (black or white) to yield age-adjusted, race-specific standardized incidence ratios for 115 Navy enlisted occupations. Ninety-five percent confidence intervals (CIs) were calculated using the Poisson distribution (Lilienfeld & Stolley, 1994). When needed, appropriate adjustment techniques were implemented to take into account multiple comparisons, providing both adjusted and unadjusted p-values. Several of the above data sources and similar methods have been used to carry out previous epidemiological studies among active-duty Navy service members (Garland, Gorham, & Garland, 1987, 1988; Garland, Gorham, Garland, & Ducatman, 1988; Garland, White, Garland, Shaw, & Gorham, 1990; Garland et al., 1990a, 1990b, 1992, 1993; Garland et al., 1996).

3.1.3 Findings

Average annual age-specific incidence rates of lung disease based on first hospitalizations were calculated for black and white male active-duty enlisted personnel between 1975 and 2001. Hospitalized incident cases ascertained during this period included cases of sarcoidosis ($n = 674$), asthma ($n = 3{,}536$), emphysema and chronic bronchitis ($n = 1{,}102$), respiratory conditions due to fumes and vapors ($n = 61$), and pneumoconiosis ($n = 51$).

Age-specific incidence rates of sarcoidosis based on first hospitalization rates peaked among white men at ages 35-39 years (6.9 per 100,000). The highest incidence rates among black men occurred at younger ages, from 25 to 29 years of age (32.8 per 100,000). There was a substantially higher sarcoidosis incidence rate among Navy enlisted blacks than whites, with the average annual rate per 100,000 equal to 24.9 among black men and 3.5 among whites. The overall black/white ratio was 7.1 ($p < 0.0001$). Higher incidence among blacks was most pronounced at younger ages.

Annual incidence rates of sarcoidosis, based on midyear population counts, declined steeply from 1975 to 2001 in both black and white Navy enlisted men (Figures 3.1.3.1 and 3.1.3.2), but the black/white ratio remained high through 1999. Sarcoidosis incidence rates dropped by more than 50% among black men after 1975, when the Navy eliminated its requirement for most routine annual chest screening radiography. Incidence in blacks declined again after 1989, when the Navy dropped its requirement for routine chest

radiographic screening at Navy entrance and separation. Pneumoconiosis incidence rates were too low throughout the study period to account for the decline in sarcoidosis rates in either race due to a shift over time in diagnosis from sarcoidosis to pneumoconiosis. Diagnosis of pneumoconiosis was particularly rare in blacks, with only 4 cases diagnosed throughout the study period. Asthma was much more common that other chronic respiratory diseases in white and black men during the study period, but asthma incidence did not appear to increase sufficiently among black men during the study period to account for a contemporaneous decline in sarcoidosis incidence among black men. Similarly, the trend in incidence rates of emphysema and chronic bronchitis and the low number of cases among black men also were not sufficient to explain the marked decline in sarcoidosis incidence among black men during the study period.

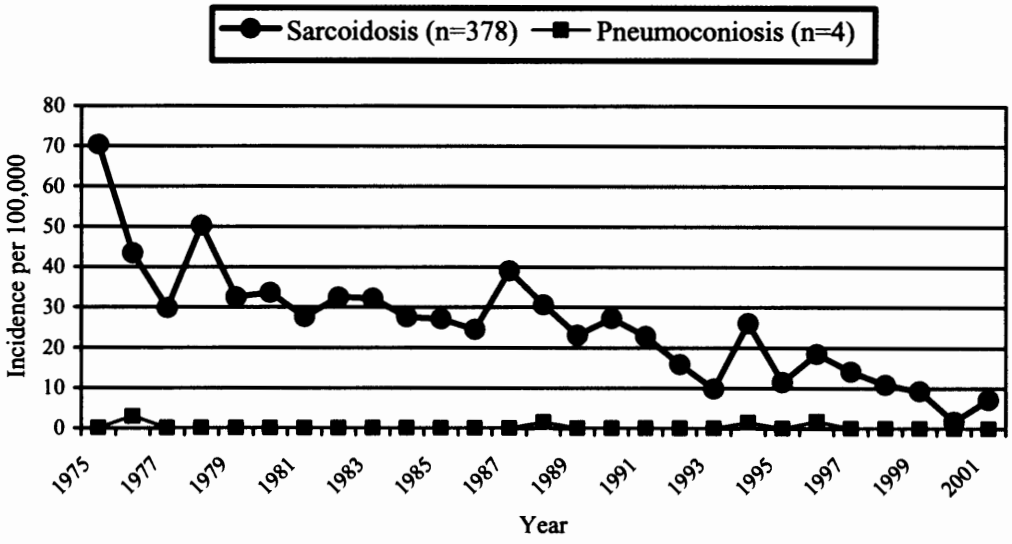


Figure 3.1.3.1. Annual incidence rate per 100,000 population for sarcoidosis and pneumoconiosis in black male active-duty enlisted Navy personnel, 1975-2001.

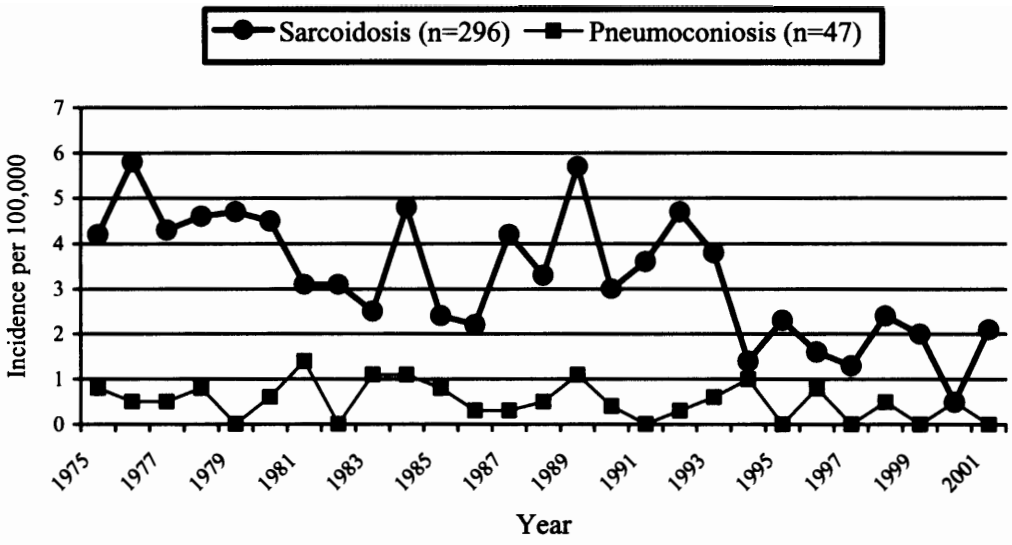


Figure 3.1.3.2 Annual incidence rate per 100,000 population for sarcoidosis and pneumoconiosis in white male active-duty enlisted Navy personnel, 1975-2001

Occupational associations were present among both white and black personnel. Black Ship's Servicemen (23 cases) and black Aviation Structural Mechanics specializing in structures (12 cases) had slightly more than twice the expected incidence of sarcoidosis in comparison with all black active-duty Navy male enlisted personnel. White Mess Management Specialists (15 cases) also had twice the expected incidence of sarcoidosis in comparison with all white active-duty Navy male enlisted personnel.

3.2 Epidemiological Study 2. Multivariate Occupational Associations Using a Nested Case-Control Approach

3.2.1 Introduction

The second epidemiological study conducted under the NLDAP had a nested case-control design and resulted in a report titled "Shipboard Duty-Station Assignments and Incidence of Sarcoidosis in Navy Personnel: A Nested Case-Control Study, 1965-2001" (Attachment B). The objectives of this study were to determine risk of sarcoidosis hospitalization according to a combination of history of duty-station assignment aboard an aircraft carrier and assignment to specific Navy enlisted occupations previously identified as being of interest according to possibility of relevant exposures. The analysis was designed to control for age, race, year of entry to naval service, history of assignment aboard an aircraft carrier, and home of record. This study also had the objective of examining time trends in risk of a diagnosis of sarcoidosis in active-duty Navy enlisted men according to Navy occupational specialty and duty station assignment, and to assess any time-dependent features in risk.

3.2.2 Methods

This nested case-control study identified Navy enlisted men (N = 1,162) with a hospital discharge diagnosis of sarcoidosis while serving on active duty during 1965-2001. A control population consisting of a 2% random sample (N= 109,037) of Navy enlisted men serving on active duty during this 37-year time period also was identified. Risks of sarcoidosis hospitalization according to type of ship and duty station, and assignment to high-risk and entry-level occupations were examined using a logistic regression model that controlled for age, race, year of entry to naval service, history of assignment aboard an aircraft carrier, and home of record. Time trends in sarcoidosis risk detected in the previous epidemiological study were examined by stratification according to accession periods in cases and controls in order to examine changes in risk over time. The present study allowed examination of trends over a longer time period beginning in 1965, in contrast to the previous study, which was limited to time trends beginning in 1975.

Demographic and other personnel information from established military data sources were used to supplement the SIDR and validate demographic information. The main sources for validation were the same as in the first epidemiological study, including DEERS and DMDC. Occupations were identified using Navy enlisted Manpower and Personnel Classification codes.

Fixed-length file records for cases and controls were constructed in identical formats using extracts from CHAMPS during 1965-2001 and the DoD SIDR records during 1989-2001. All known duty station assignments were identified throughout each individual's career history based on Unit Identification code (UIC) and onboard activity code (OBAC) assignments. The file also identified the enlisted occupational code (rating) at the time of each duty station assignment. No case or control had more than 30 duty station assignments. Among the controls, the median number of duty station assignments was 6.

Age of the cases was calculated as the difference between the first hospitalization date for sarcoidosis and the birth date. Age of the controls was calculated as the difference between date of the sixth duty station assignment and the birth date. If no sixth duty station was assigned, the date of the fifth assignment was used as a basis for the age calculation. This process was repeated until age could be calculated for all controls, including those with even a single duty station assignment. Demographic and service-related variables of interest obtained for cases and controls are the same as in the first epidemiological study, which were summarized in Table 3.1.2.2 (above).

Multiple-adjusted ORs (Ors) for sarcoidosis hospitalization according to duty station assignment and occupation were computed using logistic regression. Time trends in sarcoidosis risk were examined by stratification according to period of accession to Navy service. Time dependence of risk was analyzed by using indicator variables corresponding to period of accession to naval service.

3.2.3 Findings

Univariate findings. Statistically significant univariate differences between cases and controls were identified for a variety of service-related and demographic characteristics, including age, length of service, race, pay grade, history of service aboard an aircraft carrier, date that naval service started, age at entrance into the Navy, and regional home of record. The univariate OR for history of assignment to an aircraft carrier was approximately 2, suggesting that cases were about twice as likely as controls to have a history of assignment to an aircraft carrier.

Cases were about 3 times as likely to have their home of record in the southeastern United States than in other regions. The ORs by home region were particularly low for service members whose homes were in the Pacific (OR= 0.45, 95% CI, 0.35-0.57) or Mountain (OR= 0.33, 95% CI, 0.19-0.53) regions.

Multivariate logistic regression findings. Based on previous research that suggested higher risk or potential for exposure in certain occupational groups, ORs for the entry-level occupations of Airman, Seaman, Fireman, and the ratings (journeyman occupations) of Aviation Boatswain's Mate, Aviation Structural Mechanic Structures, other aviation ratings, Mess Management Specialist, Ship's Serviceman, and Boatswain's Mate were evaluated using logistic regression. Men in all remaining ratings were used as the reference group. ORs ratios for sarcoidosis were adjusted by logistic regression for age, race, date of entry to the Navy, rating, history of service aboard an aircraft carrier, and home of record. ORs were markedly lower in men ages 17-19 and 20-24 than in men 25 years and older. The OR for black men compared with white men was 7.7. ORs were substantially lower for men who entered the Navy after 1975 than those who entered before then. The highest statistically significant ORs for occupations were for the ratings of Aviation Structural Mechanic Structures (OR=2.4), Ship's Serviceman (OR= 2.3), and men in "other aviation ratings" (OR=1.7). The OR for history of assignment to an aircraft carrier was 1.8 (95% CI, 1.6-2.1). Having a home of record in the Southeast was associated with twice the likelihood of sarcoidosis as having a home in the Northeast, and approximately 5 times the likelihood of sarcoidosis as having a home in the Mountain region.

Multiple-adjusted ORs for sarcoidosis for white men were lower in those ages 17-19 and 20-24 than in those 25 years and older, as in men of all races combined. ORs were substantially lower among men who entered the Navy after 1975 than for those who entered before then, and declined steeply during 1975-2001. Statistically significantly high ORs were present for Mess Management Specialists (OR=2.1), Aviation Structural Mechanic (OR=2.0), men in "other aviation ratings" (OR=1.8) and Seaman (OR=1.6). The OR for history of assignment to an aircraft carrier among whites was 1.7. Having a home of record in the Southeast was associated with twice the likelihood of sarcoidosis as having a home in the Northeast, the same as for men of all races.

Multiple-adjusted ORs for sarcoidosis for black men were lower in men ages 17-19 and 20-24 than in those 25 years and older. As in white men, ORs were substantially lower in men who entered the Navy after 1975 than those who entered before 1975, and declined steeply

during 1975-2001. There were statistically significantly high-adjusted ORs for the occupations of Ship's Serviceman (OR=2.5), Aviation Structural Mechanic Structures (OR 2.0), and men in other aviation ratings (OR=1.5). The OR for Airman (1.3) was elevated, but was not statistically significantly high. Having a history of assignment to an aircraft carrier was associated with approximately twice the likelihood of sarcoidosis. Having a home of record in the Southeast also was associated with nearly twice the likelihood of sarcoidosis. ORs sarcoidosis declined as the requirements for screening Navy service members for chest disease were reduced over time during 1975-2001.

4.0 **Epidemiologically Based Conclusions**

There was a steep decline in sarcoidosis incidence in the Navy, particularly among blacks. During the period of this decline, there was no contemporaneous increase in incidence of other lung diseases, such as pneumoconioses, asthma, or emphysema or chronic bronchitis, that could account for the decline in sarcoidosis incidence.

The decline in incidence rates of sarcoidosis parallels a decline in the intensity of routine chest radiographic screening. Reduction in the frequency of routine chest radiographs for enlisted personnel may explain much of the secular decline in sarcoidosis incidence rates. It is also possible however that there has been a real decline in dust-related diseases that may have been previously misclassified as sarcoidosis. Indirect evidence for this inference stems from the fact that the efficiency of protective equipment has increased during the period in which sarcoidosis incidence has declined. Additionally, formulations of nonskid material have changed to include reduced amounts of silica and other materials that might cause dust-induced lung disease.

Both the cohort study and case-control study found that occupational assignment was related to sarcoidosis risk. The cohort study identified increased incidence rates of sarcoidosis in black and white Navy enlisted men engaged in certain Navy occupational specialties. In particular, black Ship's Servicemen had 2.3 times the expected incidence of sarcoidosis in comparison with all black Navy enlisted personnel and black Aviation Structural Mechanics specializing in structures had approximately twice the expected incidence compared with all black Navy enlisted service members. The case-control study also found occupational associations present among both white and black Navy enlisted personnel. In particular, elevated ORs were detected in certain aviation and deck ratings where exposure to nonskid materials may have occurred. The case-control study also found risk was increased in association with a history of service aboard aircraft carriers. This elevated risk persisted after multiple adjustments and was present in both black and white Navy enlisted men. Navy enlisted men assigned aboard aircraft carriers could be expected to have had a higher likelihood and degree of occupational exposure to nonskid material resulting from removal operations than men assigned ashore or to other types of ships.

Duty station and occupational assignment were only rough surrogates for any specific exposures that might be causally related to sarcoidosis or other lung diseases. However, the association of sarcoidosis with assignment to duty aboard aircraft carriers found in this

study suggests 2 possibilities. The first explanation is that the diagnosis of a dust-related fibrotic lung disease was erroneously classified as sarcoidosis. This possibility is particularly apparent in black men, for whom a high index of diagnostic suspicion may have led to a differential tendency to classify a pneumoconiosis as sarcoidosis. The other explanation was that a previously unrecognized occupational association exists for sarcoidosis that is associated with service aboard an aircraft carrier. These possibilities are worthy of further investigation, but would require better characterization of potential occupational exposures and environmental factors common to service in these occupations.

The observed decline in sarcoidosis incidence rates is encouraging. However, the relationship between declining trends in sarcoidosis and reduction in routine chest radiography suggests that many less severe cases of pulmonary sarcoidosis were historically found incidentally as a result of routine chest radiographic screening and may not have been diagnosed based on symptoms. These cases currently may go unrecognized in the Navy. Since many less severe cases of pulmonary sarcoidosis resolve spontaneously however, the effect of underdiagnosis may not pose an immediate health concern.

5.0 PATHOLOGICAL SPECIMENS SEARCH

5.1 Introduction

As part of the NLDAP, an effort was made to find any pathological materials for Navy enlisted personnel that were hospitalized with a diagnosis of sarcoidosis while on active duty at an MTF, or had a diagnosis of sarcoidosis made at a VA facility after separation from active duty. For all identified cases, the tissue repository at AFIP was searched for stored specimens. MTFs in the DoD were also contacted and asked to provide specimens.

5.2 Methods

Navy MTF search. Letters from Office of the Navy Surgeon General, Navy Bureau of Medicine and Surgery were sent to 12 major Navy MTFs that had admitted 1,273 individuals who had a discharge diagnosis of sarcoidosis while on active duty during 1965-2001. These included the 1,162 Navy enlisted men first hospitalized for sarcoidosis during 1965-2001. Each MTF was required to respond with a list of the specimens found, or with a negative report if no specimens were found.

Veterans Administration. NHRC provided the VA with a file of 5.5 million identifiers for active-duty Navy enlisted men with a record of naval service between 1965 and 2001. The VA returned a file containing VA hospitalization records for 2,657 individuals with a total of 5,139 hospitalizations for1or more diagnoses of interest. This VA file was provided to AFIP, and the AFIP tissue repository was searched for any available specimens from these cases.

5.3 Findings

The results of the search efforts are summarized below and in **Table 5.3.1**:

- 12 MTFs and AFIP were contacted and asked to provide blocks, slides, and pathology reports for 1,273 hospitalizations for sarcoidosis that occurred in Navy MTFs (**Table 4.3.1**). (MTF could not be determined or was unavailable for 55 individuals.)
- 3 MTFs and AFIP provided specimens. The remaining facilities provided negative responses concerning specimen availability.
- Naval Medical Center (NMC) San Diego provided 6 blocks for 5 individuals, NMC Pensacola provided 5 blocks for1individual, and AFIP provided 22 blocks for 7 individuals.
- NMC Portsmouth provided 104 slides for 13 cases, NMC San Diego provided 33 slides for 4 individuals, and AFIP provided 130 slides for 8 individuals (2 individuals had slides only and 6 had blocks and slides).
- Pathological specimens (blocks or slides) were available for 30/1,328 or 2.3% of hospitalizations from the MTF search.
- Pathological specimens were located at the AFIP Repository for a limited number of the 2,657 hospitalizations identified as a result of the VA search.

The overall rate of acquisition of specimens among active duty enlisted personnel with a discharge diagnosis of sarcoidosis was 2.3%. This was probably due to routine discarding of tissue blocks and other specimens by MTFs.

6.0 PATHOLOGICAL ANALYSES OF SPECIMENS

6.1 Introduction

Diagnosis of sarcoidosis is generally based on clinical and radiographic findings that can be confirmed with a biopsy revealing noncaseating granulomas (Yamamoto, Sharom, & Hosoda, 1992). Sarcoid-like granulomas have been described in many organ sites, including the lungs (Drent et al., 2000; Sharma & Bijwadia, 1993) and skin (Jones, et al., 1997; Blobstein, Weiss, & Myskowski, 1985; Jones, Maloney, & Helm, 19197). Presence of birefringent foreign bodies in these granulomas raises concern to exclude a diagnosis of pneumoconiosis. This investigation used Scanning Electron Microscopy Energy-Dispersive X-Ray Spectrometry (SEM-EDXS) for the study of mineral deposits in cases demonstrating sarcoid-like granulomas of the lungs and lymph nodes. Recent investigations employing SEM-EDXS have reported cases of systemic sarcoidosis in which birefringent foreign bodies consisting of silicon, aluminum, phosphorus, and calcium have been described (Fanburg, 1996; Kim et al., 2000). It has been suggested that the presence of birefringent foreign bodies may serve as a stimulus for granuloma formation in sarcoidosis (Walsh et al., 1993; Kim et al., 2000). Endogenous calcium carbonates and calcium oxalates are also known to occur in lung biopsy

Table 5.3.1. Number of sarcoidosis cases with pathological specimens requested and number received, by hospital, 1965-2003

Hospital	No. of case records requested 1965-2000	Number of individuals with pathology materials: With blocks	With slides only	Total	Percent	Total no. of tissue samples: Blocks	Slides
Portsmouth	373	0	13	13	3.5	0	104
San Diego	248	5	4	8	3.2	6	33
Bethesda	205	0	0	0	0.0	0	0
Jacksonville	104	0	0	0	0.0	0	0
Charleston	91	0	0	0	0.0	0	0
Great Lakes	57	0	0	0	0.0	0	0
Newport	55	0	0	0	0.0	0	0
Pensacola	44	1	0	1	2.3	5	0
Bremerton	40	0	0	0	0.0	0	0
Groton	21	0	0	0	0.0	0	0
Camp Lejeune	19	0	0	0	0.0	0	0
Corpus Christi	16	0	0	0	0.0	0	0
Hosp. unavail.	55	0	0	0	0.0	0	0
All	1,328	6	17	22	1.7	11	137
AFIP	1,328	7	2	10	0.7	22	130
Total	**1,328**	**13**	**19**	**32**	**2.3**	**33**	**267**

granulomas in up to two thirds of cases of sarcoidosis, sometimes possibly creating an occasional false positive diagnosis of pneumoconiosis (Visscher, Sharam, & Hosoda,1988).

6.2 Methods

6.2.1 Selection of material

Protocol for identification of useable case material. Any candidate material received at AFIP from an MTF, or retrieved from the AFIP Repository was reviewed under a protocol for selection of useable material. All candidate specimens were reviewed by Drs. William Travis and K. Capps of AFIP for suitability for analysis. The protocol for assessment of tissue samples for inclusion in pathological analyses was developed and agreed upon by the investigators. The following protocol was followed:

1. The individual identifying information was checked against a master file to determine if the sample was from the correct person and admission.

2. Each candidate tissue sample for inclusion in the study was reviewed by 2 qualified individuals at AFIP.

3. For samples meeting the above criteria, the following applied:

a. The sample must have been of relevant tissue (e.g., lung or lymphoid tissue).
b. The sample must have been for a diagnosis with a relationship to lung disease.
c. There must have been sufficient pathological material and it must have contained a block or unstained slide.
d. The sample must not have been degraded beyond use.

This protocol resulted in all lung or intrathoracic lymphoid tissue being included for detailed analysis. Pathological material that initially met these inclusion criteria were identified for 32 individuals, and specimens for these individuals were provided to AFIP and the External laboratory (SUNY, Syracuse) for microscopic examination. The director of AFIP portion of the pathological investigation was Dr. William Travis. The AFIP mineralogical analysis was directed by Dr. Jose Centeno. The director of the External laboratory, at SUNY Upstate Medical Center, Syracuse, NY, was Dr. Jerry Abraham.

Additional Information on Identification of Useable Material. AFIP did not make a pathological diagnosis of sarcoidosis. Because sarcoidosis is a clinical-pathological diagnosis, patients usually received an initial pathological diagnosis from AFIP of "multiple non-caseating granulomas, etiology undetermined." For this reason, sarcoidosis cases were identified according to their clinical hospital discharge diagnoses recorded at the various MTFs.

Selection of control specimens. The control specimens were a convenience sample of material identified by a search of the AFIP Repository for non-neoplastic lung disease and intrathoracic lymph node specimens that had blocks available for mineral analysis.

AFIP identified extant pathological materials for 14 individuals who had no known hospital discharge diagnosis of sarcoidosis during active duty naval service. These included 3 Navy enlisted service members who had a discharge diagnosis for an acute respiratory illness during active duty. These included 1 individual with pulmonary eosinophilia (ICD-9 Code 518.3), 1 with pneumonia (ICD-9 Code 486) and 1 an unspecified acute upper respiratory infection (ICD-9 Code 465). The 14 individuals also included 4 enlisted service members with a history of active duty Navy service, but who had no known discharge diagnosis of sarcoidosis while on active duty. These service members are denoted in the relevant tables with the phrase "No hospitalization." It also included 7 individuals for whom no career history of active duty service in the Navy could be identified and who therefore, had no record of either a naval career nor a discharge diagnosis of sarcoidosis. These individuals are denoted in the relevant tables with the phrase "No history."

Protocol for Selection of Specimens to Be Examined at AFIP and by the External laboratory. The following protocol was followed for selection of specimens to be tested by AFIP and by the External laboratory using light microscopy, and, when tissue blocks were available, by additional analytic methodologies.

1. Useable specimens identified in the NLDAP were examined at AFIP and the External laboratory. Samples from the same block were examined at both facilities.

2. Control specimens selected by AFIP for the study were examined at AFIP and the External laboratory. The same samples were examined at both facilities.

6.2.2 Analyses at AFIP

6.2.2.1 AFIP light microscopy. AFIP examined pathological materials for 30 individuals using light microscopy, and provided these materials to the External laboratory. The standard methods of preparation for histological examination of tissue at AFIP were used. Sections of 4-6 um thickness were cut on a rotary microtome with a disposable blade and mounted on glass slides. The sections were deparaffinized and stained with hematoxylin-eosin (H&E). The examination included illumination of specimens with polarized light. Pathological materials for 28 of these 30 individuals also were examined by light microscopy by the External laboratory.

6.2.2.2 AFIP mineral analyses. AFIP performed mineral analyses of 16 specimens of lung or intrathoracic lymphoid tissue by SEM-EDXS using standard methods. Specimens were included in this analysis based on availability of an adequate quantity of extant tissue that was free of mercury contamination, and availability of technical assistance. Sections of 4-6 um thickness were cut on a rotary microtome with a disposable blade, as described above. The sections were mounted on carbon disks or 222 x 60 mm Thermanox (NUNC) plastic cover slips. Prior to mounting the section on the carbon disk, the disk was washed with

concentrated H_2SO_4 (to remove Fe), then thoroughly rinsed with distilled deionized water, placed in acetone and ultrasonicated for 2 hours. The carbon disks were washed again with distilled deionized water and placed in a vacuum oven to dry for 12 hours. Prior to the SEM-EDXS, sections mounted on the carbon disks were deparaffinized with 2 changes of xylene and 2 changes of absolute ethyl alcohol. The sections mounted on plastic disks were deparaffinized and carbon coated. The samples were not polished.

A Hitachi S-3500N scanning electron microscope, a NorAm Energy Dispersive Spectrometer and KEVEX software were used to examine the tissue sections. An accelerating voltage of 20 KeV and approximately 1 nanoAmpere beam current were used, with 100-second analysis for each particle. The backscattered electron images at magnifications from 4,000x - 20,000x were used to observe the morphology of the tissues and to record the composition of the inorganic particles.

The quantitative analyses were done according to the procedure described by Abraham and Burnett (1983). Fields were searched at a magnification of 6000x, 11-12 mm working distance, 20 kV accelerating potential, and 4 cm specimen to x-ray detector. Each field area was 374 um^2 and was selected randomly and consecutively on the screening view. For each field, the field number and number of particles were recorded. For each particle, the size, chemical content, and x-ray counts were recorded. Each section was analyzed by counting the number of particles in at least 100 fields (between 100 and 200). A maximum of 20 particles were analyzed in each field. Particles containing phosphorus, sulfur, and calcium as major constituents, with smaller amounts of sodium, potassium, magnesium, and chlorine, were considered endogenous. Particles containing silica, silicates, and/or metals were considered exogenous. The number of particles detected in a given number of fields represented the numerical concentration of particles per unit volume of the sample.

6.2.3 Analyses at the External laboratory (SUNY)

Pathological material obtained using the criteria described above was prepared in duplicate by AFIP and a second sample was sent to the External laboratory at SUNY Syracuse, for comparative analyses. Details are provided below.

6.2.3.1 Light microscopy at the external laboratory. Samples prepared by AFIP were sent to the external SUNY laboratory. The external laboratory used standard pathological methods for light microscopy of lung tissue containing potential particulates, including illumination of the samples with polarized light. All the H&E stained slides were reviewed at the laboartory. Specimens suitable for further analysis were selected for standard quantitative *in situ* microanalysis of inorganic particles using SEM-EDXS.

6.2.3.2 Mineral analyses at the external laboratory. Specimens selected by the external laboratory for mineral analysis were analyzed using standard quantitative in situ microanalysis for inorganic particles using SEM-EDXS. This method has been described previously (Abraham, & Burnett, 1983). This method is appropriate for determining the burden of inorganic particles in lung or other tissues.

6.2.4 Statistical analyses

Agreement between the hospital discharge diagnosis and the microscopic pathological findings was evaluated using two-by-two tables and standard measures of agreement. Agreement between the 2 laboratories on microscopic features of the tissue was further evaluated using the Kappa statistic, a standard measure of the overall degree of agreement between observers, corrected for chance (Cohen, 1960; Landis, & Koch, 1977). Kappa values of 0.40 to 0.75 denote intermediate to good agreement above chance, while values greater that 0.75 indicate excellent agreement above chance (Landis, & Koch, 1977). The association of a history of assignment to an aircraft carrier or another type of ship with pathological features of the specimens was evaluated using ORs and their 95% CIs based on the method of Woolf (Kirkwood, & Sterne, 2003). *P*-values were determined using the chi-square test, and, when needed due to sample size limitations, Fisher's Exact Test (Armitage, & Berry, 1994: pp. 413-5). The higher the OR, the stronger the degree of association between a factor of interest and a rare or uncommon disease (Lilienfeld, & Stolley, 1994). The OR is an estimate of the relative risk of disease in exposed compared to unexposed individuals. An OR of 2.0, for example, denotes that the disease was approximately twice as likely to have occurred in individuals who were exposed to the factor of interest as in those who were not so exposed. ORs, *p*-values, and confidence limits were calculated using SAS (Cary, NC, SAS Institute). Kappa and other statistics were calculated using StatXact (Cytel, Cambridge MA).

6.3 AFIP Findings

6.3.1 AFIP light microscopic findings

Pathological findings for the materials from 30 individuals that were examined by AFIP using light microscopy are shown in **Table 6.3.1.** There were 18 individuals who had a Navy hospital discharge diagnosis of sarcoidosis (ICD-9 Code 135). Of these, 16 had a light microscopic examination of their tissue by AFIP. These included 8 who had specimens of lung parenchyma, another 2 who had tissue from trans-bronchial biopsies that included bronchial mucosa and/or lung parenchyma, 5 who had solely lymphoid tissue, and 1 whose specimen consisted solely of nasal sinus bone and mucosa. There were 14 other individuals who did not have a Navy discharge diagnosis of sarcoidosis, but whose tissue AFIP examined for the study using light microscopy. These included 8 individuals with specimens of lung parenchyma, 2 with tissue from trans-bronchial biopsies that included bronchial mucosa and/or lung parenchyma, 3 who had solely lymphoid tissue, and 1 of "soft tissue" of unspecified anatomical origin that included necrotizing granulomas.

6.3.2 AFIP Mineral analysis findings

The results of the elemental analyses of 19 specimens from 15 individuals using SEM-EDXS are presented in **Table 6.3.2**. Section A of this table presents the data and Section B provides mean values and results of a nonparametric analysis of variance (ANOVA). The elements identified included silicon, aluminum, calcium, phosphorus, sodium, and trace

amounts of titanium and other elements in some specimens. Silicon was present in all specimens that were tested, and was in the 5-20% range in 4 of the 5 samples. Aluminum was present in 4 of the 5 samples, and was in the 5-20% range in 2.

This section was contributed by Drs. Jose A. Centeno, William D. Travis, Elizabeth Meza, and Zorimar Rivera, of the AFIP Department of Environmental and Toxicological Pathology and is based on a report currently in preparation titled "Scanning Electron Microscopy for the Study of Mineral Deposits in Tissues With an Association to Sarcoidosis."

6.4 External laboratory (SUNY) Findings

6.4.1 External laboratory light microscopic findings

Results of light microscopic examinations by the external laboratory are shown in **Table 6.4.1.**

Table 6.3.1 AFIP readings of pathological materials, NLDAP, 2002-2003

ID	Hospital discharge diag-nosis	Source*	Year of tissue sample	Patient's† Race	St.	H.R.	Type of tissue‡	Pathological reading	Granu-lomas	Necro-sis	Consistent with sarcoid.?
1	Sarcoid.	AFIP	1971	B	IN	IN	Lung bx	Noncas. miliary granulomas etiology undetermined 1972	3+	Promin.	Favor infection
2	Sarcoid.	AFIP	1978	B	NC	RI	Lymph node bx	Noncas. granul'tous lymphadenitis c/w sarcoidosis 1978	3+	Punct.	Yes
3	Sarcoid.	VA	1978	B	OK	TN	Trans-bronch. bx	Noncas. confluent grans etiol. undeter. c/w sarcoid. 1978	1+	No	Yes
4	Sarcoid.	AFIP	1979	B	TX	TX	Autopsy lung	Pulmonary edema and generalized congestion 1980	No	No	No
5	Sarcoid.	AFIP	1980	W	NY	NY	Lymph node bx	Compatible with Sarcoidosis 1985	3+; focal hyalinized	No	Yes
6	518.3‖	VA	1982	B	CA	CA	Trans-bronch. bx	Noncas. granulomata etiol. undet. c/w Sarcoidosis 1982	3+	No	Yes
7	486§	VA	1982	B	SC	CT	Lymph node bx	Lymphadenitis chronic gran. c/w with Sarcoidosis 1982	3+	Punct.	Yes
8	Sarcoid.	AFIP	1990	B	VA	VA	Lymph node bx	Noncas. grans. consistent with Sarcoidosis 1990	2+	Punct.	Yes
9	No hosp.¶	VA	1990	W	LA	LA	Trans-bronch. bx	Noncas. granulomas etiol. undet. c/w Sarcoidosis 1990	3+	Punct.	Yes
10	465**	VA	1990	W	TX	TX	Lymph node bx	Noncas. granulomata, consistent with Sarcoidosis 1990	3+	No	Yes
11	Sarcoid.	AFIP	1991	W	CA	CT	Lung bx	Mult[iple] noncas. granulomas, etiol. Undet. 1991	2+	Yes***	Possi-ble†††
12	Sarcoid.	AFIP	1992	B	SC	SC	Trans-bronch. bx	Granul'tous inflamm. polarizing material/Ca oxalate 1993	2+	No	Yes
13	Sarcoid.	AFIP	1994	W	CA	CT	Aut. Lymp. Node	Noncas. granulomas consistent with Sarcoidosis 1994	1+	No	Yes
14	No hist.††	VA	1994	‡‡	NE	‡‡	Lung bx	Epithelioid noncas. granulomas etiol. undetermined 1994	1+	No	Yes
15	Sarcoid.	AFIP	1996	‡‡	NC	NC	Lymph node bx	Necrotizing granulomatous lymphadenitis 1997	2+	Punct.	Yes
16	No hist.	AFIP	2002	‡‡	CA	‡‡	Trans-bronch. bx	Organizing pneumonia 2002	No	No	No

Table 6.3.1 AFIP readings of pathological materials, NLDAP, 2002-2003

ID	Hospital discharge diag-nosis	Source*	Year of tissue sample	Patient's† Race	St.	H.R.	Type of tissue‡	Pathological reading	Granu-lomas	Necro-sis	Consistent with sarcoid.?
17	No hist.	AFIP	2002	‡‡	AL	‡‡	Trans-bron. bx¶¶	Organizing pneumonia 2002	No	No	No
18	No hist.	AFIP	2002	‡‡	NY	‡‡	Lung bx	Necrotizing granulomata, etiol. undetermined, favor infecti	3+	1+	Unlikely
19	No hist.	AFIP	2002	‡‡	IL	‡‡	Soft tissue	Necrotizing granulomas, etiol. Undet., favor infection 2002	3+	3+	No
20	No hist.	AFIP	2002	‡‡	MD	‡‡	Lung bx	Granulomatous inflammation, etiol. undetermined 2002	3+	3+	No
21	Sarcoid.	AFIP	1970	W	PA	‡‡	Lung bx	Nonnecr. miliary grans., etiol. unk. c/w sarc. cannot r/o Be	2+	No	Yes
22	Sarcoid.	AFIP	1980	B	LA	‡‡	Lung bx	Mononuclear cells, non-diag./focal calcif., etiol. undet. 198	No	No	No
23	Sarcoid.	VA	1983	B	AL	‡‡	Lymph node bx	Sarcoid granuloma 1983	‖‖	‖‖	‖‖
24	No hosp.	VA	2000	B	FL	‡‡	Trans-bron. bx¶¶	Noncas. granulomatous inflamm'n. etiology undet. 2000	3+	No	Yes
25	No hosp.	VA	1983	W	UT	‡‡	Lymph node bx	Noncas. granulomas compatible with Sarcoidosis 1983	2+	No	Yes
26	No hosp.	VA	1985	B	NY	‡‡	Trans-bronch. bx	Noncas. granulomas etiol. undeter. C/w Sarcoidosis 1985	3+	Punct.	Yes
27	Sarcoid.	VA	1996	B	SC	SC	Lung bx	Multiple noncas. granulomas, etiology undet., 1996	§§	§§	§§
28	Sarcoid.	NMCP*	1994	B	NC	‡‡	Lymph node	No narrative reading reported.	3+	Punct.	Yes
29	Sarcoid.	NMCP	1997	B	NC	‡‡	Nasal sinus	No narrative reading reported.	2+	Punct.	Yes
30	No hist.	NMCP	1994	‡‡	MA	‡‡	Trans-bronch. bx	No narrative reading reported.	2+	No	Yes
31	Sarcoid.	NMCP	1996	B	CT	‡‡	Trans-bronch. bx	No narrative reading reported.	No	No	No
32	Sarcoid.	NMCP	1994	B	VA	‡‡	Trans-bron. bx¶¶	No narrative reading reported.	No	No	No

Table 6.3.1 AFIP readings of pathological materials, NLDAP, 2002-2003

ID	Hospital discharge diagnosis	Source*	Year of tissue sample	Patient's† Race	St.	H.R.	Type of tissue‡	Pathological reading	Granulomas	Necrosis	Consistent with sarcoid.?

*Abbreviations: AFIP, Armed Forces Institute of Pathology; NMCP, Naval Medical Center Portsmouth VA; VA, Veterans Administration.

†Abbreviations: B, black; H.R., home of record in Navy career history; St., State of Social Security registration; W, white.

‡Abbreviations: bx, biopsy; Trans-bronch. bx, Transbronchial biopsy.

‖ICD9 Code 518.3, Pulmonary eosinophilia.

§ICD9 Code 486, Pneumonia, not further specified

¶No hosp., No record was found of hospitalization of this individual in a Navy hospital while on active duty.

**ICD9 Code 465, Acute upper respiratory infection.

††Abbreviation: No hist., No career history was found of Navy service by a person having this individual's Social Security Number.

‡‡Data unavailable.

‖‖Pathological analysis was not provided by AFIP. Material was labelled as lymph node biopsy but no lymph node or lung tissue was seen on slides. Material included three stained slides, but no unstained slides or blocks.

§§Pathological analysis was not provided by AFIP. No further details available.

¶¶Tissue was mainly bronchial mucosa, according to examination by SUNY of the extant material for this individual.

***Zone of necrosis.

(Dec. 31, 2003, 12:01 PM, ver. 2.5)

†††Possible, but large necrosis unusual, concerned about infection

Table 6.3.2. Scanning electron microscope-energy-dispersive x-ray spectrometry analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Block ID	Hospital discharge diagnosis*	Were particles seen by AFIP on light micro-scopy?	Ship history	Occupation	AFIP ID No.	Site or comment
1	N.A.	Sarcoidosis	Yes	None	Operations Specialist	1249	Lung
2	N.A.	Sarcoidosis	No	G.M. Destroyer	Radioman	7849	Lymphatic
3	N.A.	Sarcoidosis	Yes	G.M. Destroyer	Ship's Serviceman	0288	Block exhausted
4	A	Sarcoidosis	No	None	Ship's Serviceman	6782B	Lung
4	B	Sarcoidosis	No	None	Ship's Serviceman	6782	Lung
4	Avg.†	Sarcoidosis	No	Destroyer Escort	Ship's Serviceman	6782	Lung
5	N.A.	Sarcoidosis	Yes	Aircraft Carrier	Data Systems Technician	9975	Lymphatic
6	N.A.	Pulm. Eosin.	No	None	Hospitalman	9272	No data provided
7	N.A.	Pneumonia	No	None	Seaman Recruit	5231	Lymphatic
8	N.A.	Sarcoidosis	No	None	Yeoman	4870	Lymphatic
9	N.A.	No hosp.	Yes	None	Seaman Recruit	8634	Lymphatic
10	A	Acute URI	Yes	None	Fireman Recruit	1666	Fat

Table 6.3.2. Scanning electron microscope-energy-dispersive x-ray spectrometry analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Block ID	Hospital discharge diagnosis*	Were particles seen by AFIP on light micro-scopy?	Ship history	Occupation	AFIP ID No.	Site or comment
10	B	Acute URI	Yes	None	Fireman Recruit	1666	Lymphatic
10	C	Acute URI	Yes	None	Fireman Recruit	1666	Lymphatic
10	Avg.‡	Acute URI	Yes	Landing Ship Tank	Fireman Recruit	1666	Lymphatic
11	-	Sarcoidosis	Yes	G. M. Cruiser	Storekeeper	8553	No carbon disk at AFIP
12	A	Sarcoidosis	Yes	None	Fireman Recruit	2516	Trans-bronchial biopsy
12	B	Sarcoidosis	Yes	None	Fireman Recruit	2516	Trans-bronchial biopsy
12	Avg.†	Sarcoidosis	Yes	G. M. Cruiser	Fireman Recruit	2516	Trans-bronchial biopsy
13	N.A.	Sarcoidosis	Yes	Aircraft Carrier	Electrician's Mate	6959	No carbon disk at AFIP
14	N.A.	No history	No	None	Not applicable	5643	Lung biopsy. No SEM-EDXA data
15	N.A.	Sarcoidosis	No	Aircraft Carrier	Mess Management Spec.	8424	No carbon disk at AFIP
16	N.A.	No history	Yes	None	Not applicable	8850	SEM could not read the disk
17	N.A.	No history	No	None	Not applicable	1280	Lung

Table 6.3.2. Scanning electron microscope-energy-dispersive x-ray spectrometry analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Block ID	Hospital discharge diagnosis*	Were particles seen by AFIP on light micro-scopy?	Ship history	Occupation	AFIP ID No.	Site or comment
18	N.A.	No history	Yes	None	Not applicable	9113	SEM-EXDA not done.
19	N.A.	No history	No	None	Not applicable	0746	Soft tissue (lymphatic)
20	N.A.	No history	No	None	Not applicable	0567	Lung
21	N.A.	Sarcoidosis	Yes	None	Storekeeper	8816	Hg contaminated
22	N.A.	Sarcoidosis	No	Aircraft Carrier	Yeoman	4427	Hg contaminated, no C disk at AFIP
23	N.A.	Sarcoidosis	No	None	Boatswain's Mate	0075	Lymph node biopsy. No SEM data
24	N.A.	No hosp.	No	Amphibious Ship	Boatswain's Mate	9153	Trans-bronch. biopsy. No SEM data.
25	N.A.	No hosp.	Yes	None	Engineman	2418	Lymph node biopsy. No SEM data.
26	N.A.	No hosp.	Yes	Aircraft Carrier	Mess Management Spec.	5453	Trans-bronch. biopsy. No SEM data.
27	N.A.	Sarcoidosis	No	Aircraft Carrier	Aviation Boatswain's Mate	5424	Lung biopsy. No SEM data.
28	N.A.	Sarcoidosis	No	Aircraft Carrier	Aviation Ordnanceman	S94-8563	Lymph node biopsy. No SEM data.
29	N.A.	Sarcoidosis	No	Aircraft Carrier	Data Systems Technician	P96-9460	Nasal sinus. No SEM data.

Table 6.3.2. Scanning electron microscope-energy-dispersive x-ray spectrometry analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Block ID	Hospital discharge diagnosis*	Were particles seen by AFIP on light micro-scopy?	Ship history	Occupation	AFIP ID No.	Site or comment
30	N.A.	No history	No	None	Not applicable	94SP10259	Trans-bronch. biopsy. No SEM data.
31	N.A.	Sarcoidosis	No	Aircraft Carrier	Journalist	97PSP969	Trans-bronch. biopsy. No SEM data.
32	N.A.	Sarcoidosis	No	Aircraft Carrier	Aviation Ordnanceman	94SP8109	Trans-bronch. biopsy. No SEM data.

Table 6.3.2--*Continued (2).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Total No. of fields	Total No. of particles analyzed	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue														
			Total	Silica	Alum. silicates	Talc	Misc. silicates	Total metals	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni
1	150	60	213.5	35.7	157.1	7.1	0	14.3	7.1	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
2	150	21	74.7	67.6	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
3	N.A.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	150	29	103.2	96.1	0	0	3.6	3.6	3.6	0	0	0	0	0	.	0.0	0.0
4	150	71	252.7	32.0	217.1	0	0	3.6	3.6	0	0	0	0	0	.	0.0	0.0
4	300	100	177.95	64.05	108.55	0	1.8	3.6	3.6	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
5	100	66	352.9	48.1	187.2	10.7	21.4	85.5	16	42.8	10.7	0.0	0.0	0.0	.	0.0	0.0
6	N.A.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	150	5	17.8	3.6	7.1	0	3.6	3.6	0	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
8	100	12	64.2	0	10.7	0	0	53.5	48.1	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
9	120	3	13.6	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0
10	150	4	14.2	3.5	10.7	0	0	0	0	0	0	0	0	0	.	0.0	0.0

Table 6.3.2--*Continued (2).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Total No. of fields	Total No. of particles analyzed	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue: Total	Silica	Alum. silicates	Talc	Misc. silicates	Total metals	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni
10	42	104	1,324.8	254.8	789.8	0	242.0	38.2	0	38.2	0	0	0	0	.	0.0	0.0
10	60	106	1,428.6	215.6	1131	0	27.0	54.3	13.6	0	0	0	0	0	.	0.0	0.0
10	102	210	1,376.7	235.2	960.4	0.0	134.5	46.3	6.8	19.1	0.0	0.0	0.0	0.0	.	0.0	0.0
11	N.A.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12	55	100	970.9	203.9	271.9	19.4	106.8	368.9	48.7	80.6	0	0	0	0	.	230.6	0
12	150	55	195.7	10.7	35.6	59.9	42.7	49.9	7.1	0	0	0	0	0	.	35.6	0
12	205	155	583.3	107.3	153.75	39.65	74.75	209.4	27.9	40.3	0.0	0.0	0.0	0.0	0.0	133.1	0.0
13	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
14	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
15	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
17	100	94	507.1	116.7	208.6	5.34	74.9	101.6	37.4	21.4	0.0	0.0	0.0	0.0	.	0.0	0.0

Table 6.3.2--*Continued (2).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Total No. of fields	Total No. of particles analyzed	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue														
			Total	Silica	Alum. silicates	Talc	Misc. silicates	Total metals	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni
18	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
19	100	62	331.5	101.6	176.5	0.0	16.0	37.4	0.0	26.7	0.0	0.0	0.0	0.0	.	0.0	5.3
20	200	27	72.1	16	32	5.34	0.0	18.7	5.3	8.0	0.0	0.0	0.0	0.0	.	0.0	0.0
21	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
22	N.A.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
24	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
25	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6.3.2--*Continued (2).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Total No. of fields	Total No. of particles analyzed	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue														
			Total	Silica	Alum. silicates	Talc	Misc. silicates	Total metals	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni
30	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
32	N.A.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6.3.2--*Continued (3).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue													
	Al	Zr	Cu	Co	Au	Ba	Cr	W	Ce	I	Sn	Mo	Ag	Total
1	3.6	0.0	0.0	0.0	.	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	15.3
2	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
4	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
4	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
5	10.7	0.0	5.3	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90.5
6	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	0.0	0.0	0.0	0.0	.	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6
8	0.0	5.3	0.0	0.0	.	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.5
9	0.0	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
10	0.0	0.0	0.0	0.0	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10

Table 6.3.2--*Continued (3).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue													
	Al	Zr	Cu	Co	Au	Ba	Cr	W	Ce	I	Sn	Mo	Ag	Total
10	0.0	0.0	0.0	0.0	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
10	40.2	0.0	0.0	0.0	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.8
10	20.1	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.0
11	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12	48.7	0.0	0.0	0.0	*	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	430.2
12	0.0	0.0	7.1	0.0	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.8
12	24.4	0.0	3.6	0.0	.	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	246.0
13	.	.	.	.	.	.	.	.	.	.	.	.	.	.
14	.	.	.	.	.	.	.	.	.	.	.	.	.	.
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16	.	.	.	.	.	.	.	.	.	.	.	.	.	.
17	48.1	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	123.9

Table 6.3.2--*Continued (3).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue													
	Al	Zr	Cu	Co	Au	Ba	Cr	W	Ce	I	Sn	Mo	Ag	Total
18	.	.	.	.	.	.	.	.	.	.	.	.	.	.
19	5.3	0.0	0.0	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.3
20	0.0	0.0	2.7	2.7	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7
21	.	.	.	.	.	.	.	.	.	.	.	.	.	.
22	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	.	.	.	.	.	.	.	.	.	.	.	.	.	.
24	.	.	.	.	.	.	.	.	.	.	.	.	.	.
25	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6.3.2--*Continued (3).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

ID no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue													
	Al	Zr	Cu	Co	Au	Ba	Cr	W	Ce	I	Sn	Mo	Ag	Total
30	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31	.	.	.	.	.	.	.	.	.	.	.	.	.	.
32	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 6.3.2--*Continued (4).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathological specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

Means and *p*-values according to patient's diagnosis, specimens from all tissues

Diagnosis	No.	Total	Silica	Alum. silicates	Talc	Misc. silicates	Total metals	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni
Sarcoidosis	6	244.4	53.8	104.1	9.6	16.3	61.1	17.1	13.9	1.8	0.0	0.0	0.0	-	22.2	0.0
Other or none	3	469.4	84.1	322.5	0.0	46.0	16.6	2.3	6.4	0.0	0.0	0.0	0.0	-	0.0	0.0
No history	3	303.6	78.1	139.0	3.6	30.3	52.6	14.2	18.7	0.0	0.0	0.0	0.0	-	0.0	2.7
Kruskal-Wallis		0.7	0.7	1.2	2.5	0.7	1.7	2.2	1.9	1.0	-	-	-	-	1.0	3.0
p-value¶		0.69	0.69	0.54	0.29	0.71	0.43	0.33	0.39	0.61	-	-	-	-	0.61	0.22

Diagnosis	No.	Al	Zr	Cu	Co	Au	Ba	Cr	W	Ce	I	Sn	Mo	Ag
Sarcoidosis	6	6.4	0.9	1.5	0.0	-	2.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Other or none	3	6.7	0.0	0.0	0.0	-	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No history	3	17.8	0.0	0.9	0.9	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kruskal-Wallis		0.7	1.0	1.3	3.0	-	1.3	1.0	-	-	-	-	-	-
p-value¶		0.71	0.61	0.53	0.22	-	0.53	0.61	-	-	-	-	-	-

Table 6.3.2--*Continued (5).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) analysis of pathologica specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

Means and *p*-values according to history of ship assignment, specimens from all tissues

Ship history	No.	Total	Silica	Alum. silicates	Talc	Misc. sil's.	Total metals	Fe	Ti	Bi	Pb	In	U	Zn	Ni
Aircraft carrier	1	352.9	48.1	187.2	10.7	21.4	85.5	16.0	42.8	10.7	0.0	0.0	0.0	0.0	0.0
Other ship	4	572.0	118.5	307.5	9.9	52.8	64.8	9.6	14.9	0.0	0.0	0.0	0.0	33.3	0.0
Non-ship	7	174.3	41.0	84.6	2.5	13.5	32.7	14.0	8.0	0.0	0.0	0.0	0.0	0.0	0.8
Kruskal-Wallis statistic‖		2.9	3.6	1.3	2.1	1.7	1.0	0.6	3.0	11.0‡‡	N.A.	N.A.	N.A.	2.00	0.71
p-value for:¶															
All categories**		0.23	0.17	0.53	0.35	0.43	0.60	0.76	0.22	N.A.‡‡	N.A.	N.A.	N.A.	0.37	0.70
Any ship vs. non-ship††		0.09	0.09	0.42	0.65	0.21	0.68	0.87	0.34	N.A.§§	N.A.	N.A.	N.A.	0.24	0.40

Ship history	No.	Al	Zr	Cu	Co	Ba	Cr	W	Ce	I	Sn	Mo	Ag
Aircraft carrier	1	10.7	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other ship	4	11.1	0.0	0.9	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-ship	7	8.1	0.8	0.4	0.4	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Kruskal-Wallis statistic‖		0.9	0.7	4.6	0.7	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0
p-value for:¶													
All categories**		0.64	0.70	0.10	0.70	0.84	0.70	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Any ship vs. non-ship††		0.44	0.40	0.24	0.40	0.75	0.40	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Table 6.3.2--*Continued (6).* Scanning electron microscope-energy-dispersive x-ray spectrometry (SEM-EDXA) specimens of lung, bronchus and lymph nodes at the Armed Forces Institute of Pathology (AFIP), 2002-2003

Notes:

Periods (.) denote missing values. No values were reported by AFIP for gold or manganese.

*Navy hospital discharge diagnosis. ICD-9-CM codes are as follows: Pulmonary eosinophilia, 518.3; pneumor unspecified, 486; acute upper respiratory infection (URI), 465; No hosp., no record located of hospitalization in a Navy hospital while on active-duty Naval service; No history, no career history was located.

†Mean of results of two examinations of lung tissue.

‡Mean of results of two examinations of lymphatic tissue. Excludes data from an examination of fat tissue that yielded lower concentrations of particulates.

§Abbreviation. Tbb, Trans-bronchial biopsy of lung.

¶*p* -values are based on the Kruskal-Wallis test, a nonparametric analysis of variance. If there are significant differences among groups, the *p* -value will be less than 0.05.

‖ Value of Kruskal-Wallis statistic comparing all three groups.

**Kruskal-Wallis *p* -value for comparison of all three categories.

†† Mann-Whitney U-test *p* -value for comparison of ship with non-ship history.

‡‡Value of Kruskal-Wallis statistic was 11.0, but may be unstable because 11 of 12 values were tied at 0.0. An accurate *p* -value ordinarily cannot be determined with this proportion of tied values.

§§Value of Mann-Whitney U-test statistic was 21.0, but may be unstable because 11 of 12 values were tied at 0.0. An accurate *p* -value ordinarily cannot be determined with this proportion of tied values.

Table 6.4.1. External laboratory (SUNY) readings of pathological materials, NLDAP, 2002-2003

ID No.	Hospital discharge diagnosis	Source	Year of tissue sampling	Race	Type of tissue	Pathological reading	Granulomas	Necrosis	Consistent with sarcoidosis?
1	Sarcoid.	AFIP*	1971	B†	Lung	Lung; granulomas; some focal necrosis.	Yes	Yes	No
2	Sarcoid.	AFIP	1978	B	Lymph node bx	No dust on birefringent or polarized.	Yes	No	Yes
3	Sarcoid.	VA	1978	B	Trans-bronch. bx	Submucosal NCGs*; rare biref. dust; ?endog ca.	Yes	No	Yes
4	Sarcoid.	AFIP	1979	B	Lung	Biopsy or autopsy; nearly nl; terminal aspiration.	No‡	No‡	?‡
5	Sarcoid.	AFIP	1980	W†	Lymph node	Lymph node and fat; fibrous old grans; no giant cells.	Yes	No	No
6	518.3§	VA	1982	B	Trans-bronch. bx	No narrative reading reported.	-	-	-
7	486¶	VA	1982	B	Lymph node bx	No narrative reading reported.	-	-	-
8	Sarcoid.	AFIP	1990	B	Lymph node	Mostly NCGs, one with polys.	Yes	No	Yes
9	No hosp.**	VA	1990	W	Trans-bronch. bx	Confluent NCGs w/fibrosis; fine dust in MPH	Yes	No	Yes
10	465††	VA	1990	W	Lymph node bx	NCGs; much dust, some graphite also	Yes	No	Yes
11	Sarcoid.	AFIP	1991	W	Lung	Open bx; rare NCG. Otherwise lung nearly nl.	Yes	No	Yes
12	Sarcoid.	AFIP	1992	B	Lung	Tbb; NCGs. Only endog. calcium.	Yes	No	Yes
13	Sarcoid.	AFIP	1994	W	Lymph node	Confluent grans; some w/ macrophages w/ mixed dust.	Yes	No	Yes
14	No hist.‡‡	VA	1994	§§	Lung bx	No narrative reading reported.	-	-	-
15	Sarcoid.	AFIP	1996	§§	Lymph node	NCGs. No dust seen birefringent or polarized.	Yes	No	Yes
16	No hist.	AFIP	2002	§§	Lung	Tbb; no granulomas; considerable mixed dust.	No	No	No
17	No hist.	AFIP	2002	§§	Bronchus (Tbb)	Bronchial biopsy; Atypia? Cancer; no granulomas.	No	No	No

Table 6.4.1--*Continued*. External laboratory (SUNY) readings of pathological materials, NLDAP, 2002-2003

ID No.	Hospital discharge diag-nosis	Site	Year of tissue samp-ling	Race	Type of tissue	Pathological reading	Granu-lomas	Nec-rosis	Consis-tent with sarcoid-osis?
18	No hist.	AFIP	2002	§§	Lung	Necrotizing granulomas; much soot-like dust.	Yes	Yes	No
19	No hist.	AFIP	2002	§§	Fibrotic lymph node?	Fibrotic lymph node; necrotizing granulomas.	Yes	Yes	No
20	No hist.	AFIP	2002	§§	Lung	Necrotic; no granulomas.	No	Yes¶¶	No
21	Sarcoid.	AFIP	1970	W	Lung	Open biopsy; mixed dust in perivascular macrophages.	Yes	No	Yes
22	Sarcoid.	AFIP	1980	B	Trans. bronch. bx	Some fibrosis; alveolar MPH w/ fine dust c/w TiO_2.	No	No	No
23	Sarcoid.	VA	1983	B	Not reported	No narrative reading reported.	-	-	-
24	No hosp.	VA	2000	B	Trans. bronch. bx	NCG; endog calcium, no dust	Yes	No	Yes
25	No hosp.	VA	1983	W	Lymph node	NCGs; no dust.	Yes	No	Yes
26	No hosp.	VA	1985	B	Trans. bronch. bx	Interst. chronic inflm'n., NCG; MPH w/ mixed dust.	Yes	No	Yes
27	Sarcoid.	VA	1996	B	Trans. bronch. bx	One NCG, macrophages w mixed dust.	Yes	No	Yes
28	Sarcoid.	NMCP	1994	B	Lymph node	NCG; no dust; ?Thoracic, no gran, rare necr., s/stains?	Yes	Yes, rare	Yes
29	Sarcoid.	NMCP	1997	B	Bone and mucosa	Granulomatous inflammation with necrosis	Yes	Yes	No
30	No hist.	NMCP	1994	§§	Trans. bronch. bx	NCGs; rare Schaumann; no dust	Yes	No	Yes
31	Sarcoid.	NMCP	1996	B	Trans. bronch. bx	Rare macrophages w/ opaque dust, no granulomas.	No	No	No
32	Sarcoid.	NMCP	1994	B	Bronchus (Tbb)	Bronchial mucosa, insufficient for diagnosis	No	No	No

Table 6.4.1--*Continued.* External laboratory (SUNY) readings of pathological materials, NLDAP, 2002-2003

Notes:

*Abbreviations: A, Armed Forces Institute of Pathology; LN, lymph node; NL, normal limits; MPH, macrophages; NCG, non-caseating granuloma; NMCP, Naval Medical Center, Portsmouth, VA; Tbb, trans-bronchial biopsy; VA, Veterans Administration.

†Abbreviations: B, black; W, white.

‡ Sample that was available appeared to be normal lung tissue except for terminal aspiration.

§ICD-9-CM Code 518.3, Pulmonary eosinophilia.

** No hosp., No record was found of hospitalization of this individual in a Navy hospital while on active duty.

††ICD-9-CM Code 465, Acute upper respiratory infection

‡‡No hist., No career history was found of Navy service by a person having this individual's Social Security Number.

§§Data not available.

¶¶Lung tissue with necrosis but no granulomas noted.

6.4.2 External laboratory (SUNY) mineral analysis findings

The external laboratory performed SEM-EDXS analyses for mineral and elemental content of 23 specimens from 14 individuals, including 9 who had a history of active-duty Navy service and had been hospitalized for sarcoidosis and 5 who had no history of active-duty service in the Navy, nor of a Navy hospitalization for sarcoidosis. Results of these examinations are shown in **Table 6.4.2.** Section A of this table presents the data and Section B provides results statistical testing. Silica was reported in tissues from all but 1 of the 14 individuals. Concentrations of silica exceeded 100,000,000 particles per cubic centimeter of tissue in lung tissue from 4 individuals, including 2 with specimens of lung, and 1 each with specimens of bronchial or lymphoid tissue. Aluminum silicates were reported in specimens from all individuals, with concentrations exceeding 100,000,000 particles per cubic centimeter in lung tissue from 2 individuals, and in lymphoid tissue from another. Miscellaneous silicates were detected in lung tissues from 4 individuals, bronchial tissue from 1, and lymphoid tissue from another. Talc was present in lung tissue from 4 individuals, and in lymphoid tissue from 3. Gypsum was present in lung tissue from 1 individual, and in lymphoid tissue from another.

Mean particulate concentrations were compared in specimens from individuals who ever served aboard any Navy ship (including aircraft carriers) with specimens from those who never served aboard any Navy ship (including those with no record of a Navy enlisted career). The association with history of service aboard any ship was tested using the Mann-Whitney U-test.

6.5 Combined Laboratory Findings

This section examines the degree of agreement between AFIP and SUNY laboratories on pathological findings from readings of both of the specimens from active duty Navy enlisted service members with a hospital discharge diagnosis of sarcoidosis (ICD-9-CM Code 135).

6.5.1 Comparison of laboratory findings

There was a very high degree of agreement between the evaluation of pathological specimens by AFIP and SUNY regarding whether the material was consistent with sarcoidosis (**Table 6.5.1**). All 14 individuals whose specimens AFIP reported as consistent with sarcoidosis also were reported as consistent with sarcoidosis by the SUNY team (100%). The overall agreement was 91%. The expected agreement based on chance was 59%. The Kappa value was 0.77 ($p = 0.001$). This value of Kappa is indicative of excellent agreement (Landis, & Koch, 1977) between AFIP and SUNY readings.

One lymphoid tissue specimen that AFIP examiner read as consistent with sarcoidosis and the SUNY examiner reported as not consistent with sarcoidosis was a 24-year-old white male Data Systems Technician who had a history of assignment to an aircraft carrier.

Table 6.4.2. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus, and lymph nodes, State University of New York (SUNY) Syracuse, 2002-2003, data current through 15 January 2004; includes Armed Forces Institute of Pathology (AFIP) case numbers for reference*

ID no.	Diagnosis	Ship history	Occupation	Block no. or description	AFIP case no.	SUNY case no.	Tissue†	Analysis‖
1	Sarcoidosis	None	Operations specialist	1-Lung	1249	JA02-175	Lung	1Z
1	Sarcoidosis	None	Operations specialist	2-Lung	1249	JA02-175	Lung	2Z
1	Sarcoidosis	None	Operations specialist	4-Lung	1249	JA02-175	Lung	4Z
1	Sarcoidosis	None	Operations specialist	Avg.-Lung‖	1249	JA02-175	Lung	4Z
2	Sarcoidosis	Guided Missile Destroyer	Radioman	Lymphatic	7849	JA02-298	Lymphatic	AZ
3	Sarcoidosis	Guided Missile Destroyer	Ship's serviceman	Trans-bron. biopsy	0288	JA03-130	Lung	N.A.
4	Sarcoidosis	Destroyer Escort	Ship's serviceman	A-Lung	6782	JA02-301	Lung	TU
4	Sarcoidosis	Destroyer Escort	Ship's serviceman	B-Lung	6782	JA02-301	Lung	TU
4	Sarcoidosis	Destroyer Escort	Ship's serviceman	Avg.-Lung‖	6782	JA02-301	Lung	TU
5	Sarcoidosis	Aircraft Carrier	Data Systems Tech.	Lymphatic	9975	JA02-299	Lymphatic	AZ
8	Sarcoidosis	None	Yeoman	Lymphatic	4870	JA02-297	Lymphatic	TH

Table 6.4.2. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus, and lymph nodes, State University of New York (SUNY) Syracuse, 2002-2003, data current through 15 January 2004; includes Armed Forces Institute of Pathology (AFIP) case numbers for reference*

ID no.	Diagnosis	Ship history	Occupation	Block no. or description	AFIP case no.	SUNY case no.	Tissue†	Analysis‖
9	No Hosp.	None	Seaman Recruit	Trans-bron. biopsy	8634	JA03-131	Lung	N.A.
10	Acute URI	None	Fireman Recruit	Lymph node	1666	JA03-134	Lymphatic	N.A.
10	Acute URI	None	Fireman Recruit	Lymph node	1666	JA03-134	Lymphatic	N.A.
10	Acute URI	None	Fireman Recruit	Avg.-Lymph node	1666	JA03-134	Avg.-Lym.	N.A.
11	Sarcoidosis	Guided Missile Cruiser	Storekeeper	Lung‖	8553	JA02-303	Lung	TU
12	Sarcoidosis	Guided Missile Cruiser	Fireman Recruit	Lung-A	2516	JA02-177	Lung	AZ
13	Sarcoidosis	Aircraft Carrier	Electrician's Mate	Lung	6959	JA02-300	Lung	TU
13	Sarcoidosis	Aircraft Carrier	Electrician's Mate	Lymphatic	6959	JA02-300	Lymphatic	TU
15	Sarcoidosis	Aircraft Carrier	Mess Management Spec.	Lymphatic	8424	JA02-296	Lymphatic	TH
16	No history	None	Not applicable	Lung	8850	JA02-211	Lung	AZ
17	No history	None	Not applicable	Trans-bron. biopsy	1280	JA02-212	Bronchus	AZ

Table 6.4.2. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus, and lymph nodes, State University of New York (SUNY) Syracuse, 2002-2003, data current through 15 January 2004; includes Armed Forces Institute of Pathology (AFIP) case numbers for reference*

ID no.	Diagnosis	Ship history	Occupation	Block no. or description	AFIP case no.	SUNY case no.	Tissue†	Analysis‖
18	No history	None	Not applicable	Lung	9113	JA02-213	Lung	AZ
19	No history	None	Not applicable	Lymphatic	0746	JA02-214	Lymphatic‡	AZ
20	No history	None	Not applicable	Lung	0567	JA02-215	Lung	AZ
27	Sarcoidosis	Aircraft Carrier	Aviat. Boatswain's Mate	Lung	5424	JA03-132	Lung	N.A.

Table 6.4.2-*Continued (2)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID no.	Total no. of fields	No. of particles analyzed	Block no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue§ Total	Silica‡	Alumin. silicates	Talc	Misc. silicates	Gyp-sum	Total metals
1	200	140	1-Lung	86.1	10.1	6.7	0.0	2.0	0.0	67.2
1	200	132	2-Lung	80.6	10.1	22.8	0.0	0.0	0.0	46.7
1	200	105	4-Lung	101.3	11.2	8.6	0.0	9.3	0.0	72.2
1	600	377	Avg.-Lung‖	89.3	10.5	12.7	0.0	3.8	0.0	62.0
2	150	27	Lymphatic	2.1	0.0	1.4	0.0	0.0	0.0	0.7
3	150	24	Tbb	17.5	0.7	9.3	0.0	0.0	0.0	7.6
4	200	114	A-Lung	67.4	11.3	9.0	0.0	0.0	0.0	47.1
4	143	252	B-Lung	217.0	82.2	65.6	0.0	8.8	0.0	60.4
4	343	366	Avg.-Lung‖	142.2	46.8	37.3	0.0	4.4	0.0	53.8
5	150	139	Lymphatic	149.2	58.2	60.4	0.0	0.0	0.0	30.6
8	200	52	Lymphatic	28.3	13.9	4.6	1.0	0.0	0.0	8.8
9	150	99	Tbb	162.0	15.7	139.0	0.7	0.0	0.0	6.7
10	N.A.	N.A.	Lymph N.	74.0	59.1	12.3	0.0	0.0	0.0	2.6

Table 6.4.2-*Continued (2)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID no.	Total no. of fields	No. of particles analyzed	Block no.	Concentration of exogenous particles, millions of particles per cubic centimeter of tissue§ Total	Silica‡	Alumin. silicates	Talc	Misc. silicates	Gyp-sum	Total metals
10	N.A.	N.A.	Lymph N.	2598.4	496.9	2058.9	0.0	0.0	0.0	42.6
10	150	69	Avg.-LN	1336.2	278.0	1035.6	0.0	0.0	0.0	22.6
11	150	85	Lung‖	48.4	6.7	27.0	2.8	0.0	0.0	11.3
12	50	193	Lung-A	1032.3	497.4	332.9	0.0	59.8	39.2	102.9
13	200	93	Lung	126.6	3.9	28.9	0.0	0.0	0.0	93.3
13	121	236	Lymphatic	609.9	75.8	437.4	7.7	0.0	0.0	89.2
15	100	262	Lymphatic	296.9	39.1	63.3	72.2	4.6	0.0	117.7
16	150	39	Lung	56.1	14.2	4.1	14.2	12.8	0.0	10.9
17	80	148	Tbb-Bronch.	323.1	187.0	67.7	0.0	38.1	0.0	30.3
18	55	151	Lung	174.0	95.7	78.3	0.0	0.0	0.0	0.0
19	150	83	Lymphatic	62.9	22.1	35.3	0.0	2.2	2.2	1.1
20	200	23	Lung	17.4	4.1	5.8	0.8	0.0	0.0	6.6
27	150	79	Lung	38.6	11.2	9.7	0.0	0.0	0.0	17.7

Table 6.4.2-*Continued (3)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID	Block	Concentrations of individual metals detected in metal particles§¶															
no.	no.	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni	Al	Zr	Cu	Co	Au	Ba	Cr
1	1-Lung	61.4	5.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	2-Lung	41.1	3.6	0.0	0.5	0.1	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	4-Lung	69.5	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Avg.-Lung‖	57.3	3.2	0.2	0.2	0.0	1.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
3	Tbb	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0
4	A-Lung	11.7	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0	0.0	0.0	0.0	0.0	1.0
4	B-Lung	8.6	44.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	10.8	0.0	0.0	0.0	0.0	2.2	9.4
4	Avg.-Lung‖	10.2	26.9	0.0	0.0	0.0	0.0	0.0	0.4	0.0	21.3	0.0	0.0	0.0	0.0	1.1	5.2
5	Lymphatic	1.3	18.2	5.2	0.0	0.0	0.0	0.0	1.3	0.0	5.9	0.0	1.3	0.0	1.3	0.0	0.0
8	Lymphatic	3.6	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.5	0.0	1.5
9	Tbb	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Lymph node	2.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6.4.2-*Continued (3)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID	Block	Concentrations of individual metals detected in metal particles§¶															
no.	no.	Fe	Ti	Bi	Pb	In	U	Mn	Zn	Ni	Al	Zr	Cu	Co	Au	Ba	Cr
10	Lymph node	9.1	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.2	0.0	0.0	0.0	0.0	0.0	0.0
10	Avg.-Lung‖	5.6	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0
11	Lung‖	1.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.5	1.5
12	Lung-A	32.4	34.5	6.1	0.0	0.0	0.0	14.2	0.0	4.1	12.2	32.5	0.0	0.0	0.0	0.0	0.0
13	Lung	9.7	87.2	0.0	9.7	0.0	0.0	0.0	0.0	1.5	9.3	0.0	0.0	0.0	0.0	0.0	21.9
13	Lymphatic	0.9	79.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	6.0
15	Lymphatic	11.3	73.1	0.0	0.0	0.0	0.0	0.0	6.2	10.3	1.0	0.0	2.9	0.0	1.0	12.4	7.2
16	Lung	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Bronchus	5.7	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	5.7
18	Lung	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	1.1	0.0
20	Lung	0.8	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.8
27	Lung	8.4	7.1	0.0	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	4.6

Table 6.4.2-*Continued (4)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID no.	Block no.	Concentrations of individual metals detected in metal particles § ¶ Ag	W	Ce	Nd	I	Sn	Comment
1	1-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	2-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	4-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	Avg.-Lung‖	0.0	0.0	0.0	0.0	0.0	0.0	-
2	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	Zr in Zr silicate
3	Tbb	0.0	0.0	0.0	0.0	0.0	0.0	
4	A-Lung	0.0	0.0	0.0	0.0	0.0	0.0	Al with P
4	B-Lung	0.0	0.0	0.0	0.0	0.0	0.0	FeCr; Al with P; Ti with P
4	Avg.-Lung‖	0.0	0.0	0.0	0.0	0.0	0.0	-
5	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	Au with Cu; Al with Ti
8	Lymphatic	1.5	0.0	0.0	0.0	0.0	0.0	None
9	Tbb	0.0	0.0	0.0	0.0	0.0	0.0	
10	LN	0.0	0.0	0.0	0.0	0.0	0.0	

Table 6.4.2-*Continued (4)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID	Block	Concentrations of individual metals detected in metal particles § ¶						
no.	no.	Ag	W	Ce	Nd	I	Sn	Comment
10	LN	0.0	0.0	0.0	0.0	0.0	0.0	
10	Avg.-Lung‖	0.0	0.0	0.0	0.0	0.0	0.0	
11	Lung‖	2.4	0.5	0.0	0.0	1.5	0.0	FeCrNi; AgI
12	Lung-A	0.0	0.0	0.0	0.0	0.0	0.0	None
13	Lung	0.0	0.0	0.0	0.0	0.0	0.0	FeCrNi; FeCr; AlTi; AlCr;CrPbTi
13	Lymphatic	0.0	0.0	4.3	4.3	0.0	0.0	None
15	Lymphatic	2.9	0.0	0.0	0.0	0.0	0.0	BaS; FeCrNi; TiFe; FeZn; AgAu; ZnBaS
16	Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
17	Bronchus	0.0	0.0	0.0	0.0	0.0	0.0	Ba in BaS; Cr in FeCr
18	Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
19	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	Al and Ba in one particle with P and S
20	Lung	0.0	0.0	0.0	0.0	0.0	0.0	FeCr; CoS
27	Lung	0.0	0.0	0.0	0.0	0.0	0.0	

Table 6.4.2-*Continued (5.1)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

Means and p-values according to history of ship assignment

		Mean concentration of exogenous particles, millions of particles per cm^3										
				Alum.		Misc.	Gyp-	Total	Individual metals§¶			
Ship history	No.	Total	Silica‡	silicates	Talc	silicates	sum	metals	Fe	Ti	Bi	Pb
All Ship	9	206.0	73.8	63.4	8.3	7.6	4.4	48.4	8.3	29.0	1.3	1.2
Non-ship ***	9	249.9	71.2	153.7	1.9	6.3	0.2	16.6	8.1	6.0	0.0	0.0
Mann-Whitney *U*		35.0	30.0	39.0	34.5	38.0	41.0	61.0	54.0	63.0	46.0	46.0
p-value		0.66	0.35	0.89	0.53	0.80	0.94	0.07	0.22	0.05	0.45	0.45

. . .

Table 6.4.2-*Continued (5.2)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

Means and p-values according to history of ship assignment

		Mean concentration of individual metals detected in metal particles§¶									
Ship history	No.	In	U	Mn	Zn	Ni	Al	Zr	Cu	Co	Au
All Ship	9	0.0	0.0	1.7	0.9	1.9	5.5	3.7	0.6	0.0	0.3
Non-ship ***	9	0.0	0.2	0.0	0.0	0.0	1.3	0.0	0.0	0.3	0.2
Mann-Whitney *U*		0.0	36.0	46.0	51.0	58.5	50.5	49.5	54.0	36.0	44.0
p -value		-	0.32	0.45	0.20	0.03	0.35	0.15	0.07	0.32	0.63

Table 6.4.2-*Continued (5.3)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

		Mean concentrations of individual metals detected in particles§¶							
Ship history	No.	Ba	Cr	Ag	W	Ce	Nd	I	Sn
All Ship	9	1.7	4.5	0.6	0.1	0.0	0.0	0.2	0.0
Non-ship ***	9	0.5	0.9	0.2	0.0	0.0	0.0	0.0	0.0
Mann-Whitney *U*		49.0	53.5	46.0	45.0	0.0	0.0	45.0	0.0
p-value		0.37	0.21	0.45	0.32	-	-	0.32	0.00

Table 6.4.2-*Continued (5.4)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

		Mean concentration of exogenous particles, millions of particles per cm3										
				Alum.		Misc.	Gyp-	Total	Individual metals§¶			
Disease	No.	Total	Silica‡	silicates	Talc	silicates	sum	metals	Fe	Ti	Bi	Pb
Sarcoidosis	11	179.2	62.6	53.4	6.9	6.6	3.6	46.0	12.3	24.4	1.0	1.0
Not sarcoidosis	7	304.5	88.1	195.1	2.2	7.6	0.3	11.2	1.7	6.7	0.0	0.0
Mann-Whitney *U*		27.0	23.0	29.0	35.0	36.0	37.0	60.0	61.0	53.0	49.0	49.0
p -value		0.30	0.16	0.39	0.71	0.80	0.80	0.05	0.04	0.19	0.14	0.14

Table 6.4.2-*Continued (5.5)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

		Mean concentration of individual metals detected in metal particles§¶									
Disease	No.	In	U	Mn	Zn	Ni	Al	Zr	Cu	Co	Au
Sarcoidosis	11	0.0	0.1	1.4	0.7	1.5	4.6	3.0	0.5	0.0	0.3
Not sarcoidosis	7	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.4	0.0
Mann-Whitney *U*		0	42.0	49.0	52.5	52.5	45.0	45.5	49.0	33.0	49.0
p-value		-	0.43	0.14	0.08	0.08	0.53	0.25	0.14	0.21	0.14

Table 6.4.2-*Continued (5.6)*. Scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

		Mean concentrations of individual metals detected in particles§¶							
Disease	No.	Ba	Cr	Ag	W	Ce	Nd	I	Sn
Sarcoidosis	11	1.4	3.8	0.6	0.0	0.0	0.0	0.1	0.0
Not sarcoidosis	7	0.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Mann-Whitney *U*		41.0	50.5	49.0	42.0	0.0	0.0	42.0	0.0
p-value		0.79	0.23	0.14	0.43	-	-	0.43	-

Table 6.4.2-*Continued (6)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

Notes:

*Analyses were performed using the method of Abraham and Burnett (1983). The External Laboratory noted that the data above were subject to change; data are for the period through 15 January 2004.

†Abbreviation: LN, Lymph node.

‡Silica refers to crystalline silica, not to the element Silicon or any other association.

‖Average was used for statistics if all data were from lung tissue, otherwise only data from lung tissue were used. Abbreviations: Avg., average; nd, Not detectable; TU, Transfer unstained; TH, Transfer H&E; Unk., Unknown.

§Abbreviation: nd, None detectable.

¶Particles may contain more than one metal; these are not detailed here. Much endogenous calcium and iron were not tabulated, e.g, calcium carbonates, oxalates, hemosiderin, sodium and sulfates.
elements also were seen, with some metals not tabulated here. Particle size data were not tabulated.

Table 6.5.1. Agreement between AFIP reading of pathological material as consistent with sarcoidosis and SUNY reading of the same material, for individuals with a Navy career and hospitalization history available, including those with a discharge diagnosis or sarcoidosis, other disease, or no recorded Navy hospitalization, 2002-2003

SUNY read as consistent with sarcoidosis	AFIP read as consistent with sarcoidosis			
	Yes*	No	Total	% Agreement
Yes	14	0	14	100.0
No†	2	5 †	7	71.4
Total	16	5	21	90.5

Overall agreement = 90.5 %

Expected agreement = 58.7 %

Kappa‡ = 0.77 $p < 0.001$

95% Confidence Interval = 0.50 to 1.00

*Includes "possible sarcoidosis."

†Includes one specimen that AFIP read as not consistent with sarcoidosis and SUNY read as a question mark.

‡Kappa values greater than 0.75 indicate excellent agreement beyond chance (Landis &d Koch, 1977).

(XLS, 30 Dec 2003, 1320, v 4.1)

All pathological materials examined from individuals with no history with a discharge diagnosis of sarcoidosis while on active duty (3 individuals) or record of hospitalization in a Navy MTF (4 individuals) were reported by AFIP to be consistent with sarcoidosis. These individuals may have developed sarcoidosis after their Navy hospitalization, or their sarcoidosis may have been previously missed.

External laboratory (SUNY) findings. There were 22 individuals whose specimens were examined by SUNY and who had Navy career and hospitalization records available (**Table 6.4.1**). 17 had a Navy hospital discharge diagnosis of sarcoidosis during active duty. Of these, 10 (59%) were read as consistent with sarcoidosis by the SUNY laboratory.

7 individuals with a hospital discharge diagnosis of sarcoidosis were considered by the external laboratory as not consistent with sarcoidosis. Details of these individuals are summarized below:

One individual was a 24-year-old black male Operations Specialist who had no career history of assignment to an aircraft carrier or other ship. SUNY read his lung tissue as "Granulomas; some focal necrosis." The SUNY pathology team reported that there were opaque and birefringent particles in the granulomas. These particles were reported as consistent with titanium dioxide, and not consistent with silica or talc. They were reported as not of endogenous origin. AFIP described the specimen as "Noncaseating miliary granulomas, etiology undetermined." The AFIP examiner noted "3+ granulomas" with "prominent necrosis, favor infection." (1).

The second was a 35-year-old black male Ship's Serviceman who had been assigned to an Escort Ship, although not an aircraft carrier. His lung tissue specimen was from an autopsy. AFIP read the specimen as "pulmonary edema and generalized congestion." SUNY read it as "nearly normal" except for terminal aspiration. Both laboratories reported seeing no granulomas and no necrosis. SEM-EDXS analysis by AFIP revealed 64 million particles of silica and 109 million particles of aluminum silicates per cubic cm of tissue. Iron (4 million particles per cubic cm) and miscellaneous silicates (2 million particles per cubic cm) were also present. (4).

Another individual was a 24-year-old white man who served as a Seaman and Ship's Serviceman aboard an aircraft carrier, a guided missile destroyer, an escort ship, a destroyer tender, and a frigate preceding his diagnosis of sarcoidosis in 1978. His lymph node biopsy was read by SUNY as "fibrous old granulomas; no giant cells." SUNY pathologists reported that the granulomas were noncaseating. According to SUNY, the specimen contained some birefringent particles, and the particles in this material were read as consistent with silica. There were no particles consistent with talc. AFIP had read the same specimen as "Compatible with Sarcoidosis" and noted 3+ focal hyalinized granulomas without necrosis. AFIP noted a few small black particles, but no birefringent particles (5).

The fourth individual was a 29-year old black male Yeoman who previously was a Seaman assigned aboard an aircraft carrier. His pathological material was a transbronchial biopsy

that was read by SUNY as "Some fibrosis; alveolar macrophages w/ fine dust consistent with TiO_2." The SUNY examiner indicated that the fibrosis was associated with the TiO_2 (titanium dioxide) particles. Birefringent particles of unspecified morphology also were noted. The AFIP examiner also had read this trans-bronchial biopsy specimen as not consistent with sarcoidosis. AFIP read the specimen as "Mononuclear cells, non-diagnostic/focal calcification etiology undetermined." They reported no granulomas or necrosis and considered the material nondiagnostic. (22).

The fifth individual was the 44-year-old black male Dental Technician mentioned earlier (in Section 5.5.1). His specimen was nasal sinus and bone, and was considered consistent with sarcoidosis by AFIP but not SUNY (29).

The sixth person was a 37-year-old black male Air Traffic Controller who had a history of assignment to an aircraft carrier and an amphibious ship (LHD). He had previously been an Aviation Structural Mechanic specializing in hydraulic systems. His trans-bronchial biopsy of lung parenchymal tissue specimen was read by AFIP as containing no granulomas and as not consistent with sarcoidosis (**Table 6.3.1**). It was read by SUNY as "Tbb; rare macrophages with opaque dust, no granulomas." (31).

The seventh individual was a 37-year-old black man who had served aboard an aircraft carrier, as an Airman and Aviation Ordnanceman. The AFIP examiner saw no granulomas in the specimen, and read it as not consistent with sarcoidosis. The SUNY examiner also saw no granulomas, but noted that the specimen consisted mainly of bronchial mucosa, with insufficient lung parenchyma available for evaluation. Both AFIP and SUNY examiners noted that there were no particles visible in the specimen. (32).

In summary, the individuals on whom SUNY and AFIP were not in general agreement were drawn from a variety of occupations and had a wide range of pathological characteristics on light microscopy and SEM-EDXS.

Of 5 individuals who had no Navy history of discharge diagnosis of sarcoidosis whose specimens were examined, all were classified by the external laboratory as consistent with sarcoidosis. These 5 included 1 who had a Navy hospitalization solely for an acute upper respiratory infection while on active duty and 4 who had no record of an active-duty Navy hospitalization.

Confirmation of hospital discharge diagnosis of sarcoidosis. If AFIP and SUNY microscopic readings are regarded as standards against which the validity of the clinical diagnosis may be assessed, the results suggest that the hospital diagnosis of sarcoidosis was somewhat specific, but not necessarily sensitive, at least within the limited material that was available. This would not constitute a problem from a clinical perspective, because an individual who was free of symptoms or who had an acute respiratory illness would not generally be diagnosed as a case of sarcoidosis based solely on the existence of noncaseating granulomas or other hallmarks of sarcoidosis in a pathological specimen. A possible exception might be made if occasional pathological features that are uncommon sentinels of sarcoidosis, such as Schaumann bodies, are reported from microscopic analysis

of a pathological specimen. However, since the sample size was small and not necessarily representative of all individuals with a hospital discharge diagnosis of sarcoidosis, the results cannot be generalized.

Laboratory agreement on detailed pathological features. **Table 6.5.2** shows the degree of agreement between AFIP and the External laboratory on detailed pathological features. The overall percentage agreement between AFIP and the external laboratory was very high on most pathological features. For example, there was 100% agreement on presence of granulomas and 87.5% agreement on whether the specimen was consistent with sarcoidosis and on whether particles were present in the specimen. There was greater divergence on presence of endogenous birefringent particles. This may, in part, be due to subtle differences in criteria for reporting endogenous or birefringent particles between the 2 laboratories, or possibly differences in technique.

Laboratory agreement on SEM-EDXS results.
AFIP provided a direct comparison of SEM-EDXS data on 10 samples from 7 individuals whose pathological materials were examined using SEM-EDXS by both laboratories **(Appendix Table 1)**. This comparative analysis was provided by Dr. Jose Centeno of AFIP. 4 of the silica concentrations reported by AFIP were higher than those provided by SUNY, and 6 were lower. 8 of the aluminum silicate concentrations reported by AFIP were higher than those from AFIP, and 2 were lower. Further known information on the individuals whose pathological material was examined is provided in **Appendix Tables 2-6.**

6.6 Aircraft carrier, other ship assignments, and laboratory findings

Both laboratories performed light microscopic examinations of tissue specimens that included a search for silica-like and birefringent particles. This part of the report examines the presence of particles and pathological features in the specimens according to history of assignment to aircraft carriers. In order to be as inclusive as possible, some analyses were performed without limitation regarding whether the diagnosis was sarcoidosis. Findings from AFIP are described first, then those from SUNY. In general AFIP examination tended to show little or no association between history of assignment to an aircraft carrier and features such as silica-like and birefringent particles. However, a trend suggestive of a possible correlation of aircraft carrier assignment with silica-like particles was seen when the analysis was limited to lung parenchyma. The findings from SUNY also were not

Table 6.5.2. Agreement between AFIP and SUNY on microscopic features of specimens, active-duty Navy enlisted men who received a hospital discharge diagnosis of sarcoidosis (microscopic tissue examinations performed during 2002-2003)

Microscopic feature	No. of individuals whose material was reported for each microscopic feature below as: Both "Yes"	Both "No"	AFIP "Yes" SUNY "No"	AFIP "No" SUNY "Yes"	Total*	No. missing	Overall percentage agreement	Kappa	*p*	95% Confidence limits Lower	Upper
Consistent with sarcoidosis	9	5	2	0	16	2	87.5	0.73	*< 0.01*	0.41	1.00
Granulomas present	12	4	0	0	16	2	100.0	1.00	*< 0.0001*	1.00	1.00
Necrosis present	3	9	4	0	16	2	75.0	0.46	*0.06*	0.07	0.84
Any particles present	6	8	1	1	16	2	87.5	0.75	*<0.01*	0.42	1.00
Silica-like particles †	1	12	2	1	16	2	81.3	0.29	*0.35*	-0.30	0.89
Birefringent particles	3	8	3	2	16	2	68.8	0.31	*0.30*	-0.17	0.79
Endogenous particles	0	12	3	1	16	2	75.0	-0.10	*1.00*	-0.26	0.06

*Pathological materials from 16 individuals in common were reported by both laboratories for all microscopic features above. Pathological specimens from 2 individuals were excluded from this analysis because there was no report on material from one individual from either laboratory, and a report on material from the one individual provided only by SUNY. These 2 individuals are included in the category "Missing" (above).

†Includes report of possible silica particles, silica and silicates.

statistically significant, but suggested a possible trend between history of assignment to an aircraft carrier and presence of silica or silica-like and birefringent particles (see below).

6.6.1 AFIP findings

According to light microscopic analyses by AFIP of specimens from 16 individuals with a history of a sarcoidosis diagnosis in a Navy hospital, individuals with a history of assignment to an aircraft carrier did not differ significantly from those without such a history on any microscopic feature, compared with those who had never been assigned aboard a ship (**Table 6.6.1.1**). There were 2 individuals with a discharge diagnosis of sarcoidosis who were originally thought to have sufficient pathological material for analysis, but whose samples ultimately were considered inadequate for analysis by AFIP. Material from these individuals was therefore not included in the analysis (23, 27).

When data on presence of silica-like particles were stratified according to type of tissue (lung parenchyma or lymphoid), individuals who had a history of assignment to an aircraft carrier also did not differ significantly from those without such a history (**Table 6.6.1.2**). However, the OR for silica-like particles in those with a history of assignment to an aircraft carrier rose to 2.5, which was higher than the OR of 1.0 in the combined analysis of lung and lymphoid tissue (**Table 6.6.1.1**). The OR when the analysis was limited to lymphoid tissue was 0.71, which was slightly lower than the OR of 1.0 from the combined analysis. SEM-EDXS by history of ship assignment is shown in **Table 6.3.2**. None of the associations were statistically significant, although there were trends suggestive of possibly higher concentrations of silica, aluminum silicates, total metals, Ti, Al, Zr, Cu, Co, Ba, and W.

Analyses also were performed according to history of assignment to any type of ship, but no association reached statistical significance except for a negative association of assignment to any ship and presence of birefringent particles (**Table 6.6.2).**

In order to assess the effect of sample size limitations, above analyses were repeated including all 30 individuals on whom AFIP provided data from a light microscopic examination (**Table 6.6.3** for carrier history and **Table 6.6.4** for history of assignment to any ship). As with the previous analyses limited to sarcoidosis cases, there were no statistically significant associations. The individuals who did not have a discharge diagnosis of sarcoidosis and were included in this broader analysis, included 1 individual who was hospitalized for pulmonary eosinophilia, 1 for pneumonia due to an unknown organism, and1for an acute upper respiratory infection that was not further specified. There were also 4 individuals who had no history of hospitalization while in the Navy, and 7 who had no history of service in the Navy, nor any Navy hospitalization. Further details on the characteristics of these and other individuals are shown earlier (**Table 6.3.1**).

Table 6.6.1.1 Microscopic findings according to aircraft carrier assignment history, individuals with a hospital discharge diagnosis of sarcoidosis (ICD-9-CM Code 135), AFIP, 2002-2003

Aircraft carrier assignment history†	Findings of AFIP examination													
	Granulomas		Necrosis		Any particles		Endog. particles		Silica-like particles*		Polarizing particles		Consistent with sarcoid.	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No†
Carrier (N = 8)	5	3	3	5	2	6	1	7	1	7	1	7	5	3
Noncarrier (N = 8)	7	1	4	4	5	3	2	6	1	7	5	3	6	2
Total (N = 16)	12	4	7	9	7	9	3	13	2	14	6	10	11	5

Odds ratio	Odds ratios						
	Granulomas	Necrosis	Any particles	Endog. particles	Silica-like particles*	Polarizing particles	Consistent with sarcoid.
Carrier vs. noncarrier	**0.24**	**0.60**	**0.20**	**0.43**	**1.00**	**0.09**	**0.56**
p‡	*0.57*	*1.00*	*0.31*	*1.00*	*1.00*	*0.12*	*1.00*
Lower 95% conf. limit	0.02	0.08	0.02	0.03	0.05	0.01	0.06
Upper 95% conf. limit	3.02	4.40	1.71	5.98	19.36	1.08	4.76

*Includes "possible" silica particles and those described as silica or silicates.
†There were two individuals for whom AFIP reported no light microscopic examination results (ID Nos. 23 and 27). One of these had no history of assignment to an aircraft carrier nor any other ship, and the other had a history of assignment to an aircraft carrier and an amphibious ship.
‡Based on Fisher's exact test.

(XL7. December 30 2003, 1:45:0 PM, v. 3.3)

6.6.1.2. Stratified analysis of microscopic findings of silica-like particles, according to aircraft carrier assignment, individuals with a hospital discharge diagnosis of sarcoidosis ICD-9-CM Code 135), AFIP, 2002-2003*

A. Lung tissue*

Aircraft carrier assignment history	No.	Silica-like particles Yes	No
Carrier	3	1	2
Noncarrier	6	1	5
Total	9	2	7

Odds ratio	
Carrier vs. noncarrier	**2.5**
p †	*1.00*
Lower 95% confidence interval	0.10
Upper 95% confidence interval	62.6

B. Lymphatic tissue

Aircraft carrier assignment history	No.	Silica-like particles Yes	No
Carrier	3	0	3
Noncarrier	2	0	2
Total	5	0	5

Odds ratio	
Carrier vs. noncarrier	**0.71**
p †	*1.00*
Lower 95% confidence interval	0.01
Upper 95% confidence interval	53.1

*This was a stratified analysis of 9 individuals who had lung parenchymal tissue available, and 5 individuals who had only lymphatic tissue available. Two individuals were excluded due to tissue that was neither lung parenchyma nor lymphatic. One had only bronchial mucosa available and the other had only nasal sinus mucosa and bone available. There were also 2 individuals for whom no report of light microscopic examination was received).
†Based on Fisher's Exact Test.

Table 6.6.2 Microscopic findings according to ship assignment history, individuals with a hospital discharge diagnosis of sarcoidosis (ICD-9-CM Code 135), AFIP, 2002-2003

	Findings of AFIP examination											
Ship assignment history	Granu-lomas		Necro-sis		Any particles		Endogenous particles		Silica-like particles*		Polarizing particles	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Any ship (N = 13)	9	4	5	8	5	4	1	12	2	11	3	10
No ship (N = 3)	3	0	2	1	5	3	2	1	0	3	3	0
Total (N = 16)	12	4	7	9	10	7	3	13	2	14	6	10

	Odds ratio					
Ship assignment history	Granu-lomas	Necro-sis	Any particles	Endog. particles	Silica-like particles*	Polarizing particles
Any ship vs. no ship	**0.30**	**0.31**	**0.75**	**0.04**	**1.52**	**0.05**
p†	*0.53*	*0.55*	*0.55*	*0.07*	*1.00*	*0.04*
Lower 95% conf. limit	0.01	0.02	0.02	0.00	0.05	0.00
Upper 95% conf. limit	7.53	4.41	4.41	0.97	43.45	1.24

*Includes "possible" silica particles and those described as silica or silicates.

†Based on Fisher's exact test.

Table 6.6.3 Microscopic findings according to aircraft carrier assignment history, all individuals with microscopic data, AFIP, 2002-2003

	AFIP examination findings											
Aircraft carrier assignment history	Granulomas		Necrosis		Any particles		Endogenous particles		Silica-like particles*		Polarizing particles	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Yes ($N = 9$)	6	3	4	5	3	6	2	7	1	8	2	7
No ($N = 21$)	18	3	9	12	10	11	6	15	3	18	9	12
Total ($N = 30$)	24	6	13	17	13	17	8	22	4	26	11	19

	Odds ratio					
Aircraft carrier assignment history	Granulomas	Necrosis	Any particles	Endog. particles	Silica-like particles*	Polarizing particles
Yes vs. no	**0.33**	**1.07**	**0.55**	**0.71**	**0.75**	**0.38**
p†	*0.33*	*1.00*	*0.69*	*1.00*	*1.00*	*0.42*
Lower 95% conf. limit	0.05	0.22	0.11	0.11	0.07	0.06
Upper 95% conf. limit	2.12	5.14	2.80	4.47	8.36	2.29

*Includes "possible" silica particles and those described as silica or silicates.

†Based on Fisher's exact test.

(XL10 December 30, 2003, 1:50 PM v. 2.3)

Table 6.6.4 Microscopic findings according to ship assignment history, all individuals with microscopic data, AFIP, 2002-2003

Ship assignment history	AFIP examination findings											
	Granu-lomas		Necro-sis		Any particles		Endog. particles		Silica-like particles*		Polarizing particles	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Any ship (N =15)	11	4	6	9	6	9	3	12	2	13	5	10
No ship (N = 15)	13	2	7	8	7	8	5	10	2	13	6	9
Total (N = 30)	24	6	13	17	13	17	8	22	4	26	11	19

Ship assignment history	Odds ratio					
	Granu-lomas	Necro-sis	Any particles	Endog. particles	Silica-like particles*	Polarizing particles
Any ship vs. no ship	**0.42**	**0.76**	**0.76**	**0.50**	**1.00**	**0.75**
p†	*0.65*	*1.00*	*1.00*	*0.68*	*1.00*	*1.00*
Lower 95% conf. limit	0.06	0.18	0.18	0.10	0.12	0.17
Upper 95% conf. limit	2.77	3.24	3.24	2.63	8.21	3.33

*Includes "possible" silica particles and those described as silica or silicates.
†Based on Fisher's exact test.

6.6.2 SUNY findings

The results of corresponding analyses by SUNY are shown in **Table 6.6.5.1**. In addition to features reported by AFIP, SUNY reported on particles within granulomas, opaque and birefringent particles, TiO_2, and talc. SUNY reported light microscopic findings for 17 individuals with a history of hospitalization for sarcoidosis. Analyses included all sarcoidosis cases reported by AFIP plus 1 additional case (I.D. No. 27).

Microscopic features of all specimens from all sites from individuals with a history of assignment aboard an aircraft carrier were not significantly different from those without such a history. However, there were 2 possible trends that, while not statistically significant, were of interest. Individuals with a history of aircraft carrier assignment were 5.7 times more likely to have silica-like particles, silica, or silicates visible on microscopy than individuals who had never been so assigned. Those with an aircraft carrier history also were 5.0 times more likely to have birefringent particles present.

When data on silica-like particles were stratified according to type of tissue (lung parenchyma or lymphoid tissue) individuals who had a history of assignment to an aircraft carrier also did not differ significantly from those without such a history (**Table 6.6.5.2**). The OR for presence of silica-like particles in those with a history of assignment to an aircraft carrier was 5.6, approximately the same as in the combined analysis of lung and lymphoid tissue (5.7). The OR when the analysis was limited to lymphoid tissue was 3.0.

SUNY SEM-EDXS of specimens from all tissues combined by ship (**Table 6.4.2**) revealed no statistically significant associations, but there were nonsignificant trends suggestive of possibly higher concentrations of particulates in individuals who had a history of assignment to any type of Navy ship.

Also among specimens from all tissues combined, individuals with a history of assignment to any ship did not differ significantly from those without such a history for any light microscopic features (**Table 6.6.6**). The association of history of assignment to any ship with silica-like particles was considerably weaker than in the comparison of data limited to aircraft carriers (**Table 6.6.5.1**). The trend with birefringent particles that was seen for history of aircraft carrier assignment was not present for a history of assignment to any ship. This suggests that the trend toward a possible positive association of silica-like and birefringent particles with a history of assignment to aircraft carriers may have been diluted when all ships were included.

Table 6.4.2-*Continued (4)*. Scanning electron Microscope-energy dispersive x-ray analysis (SEM-EDXA) of pathological specimens of lung, bronchus and lymph nodes at State University of New York (SUNY), Syracuse, 2002-2003

ID	Block	Concentrations of individual metals detected in metal particles § ¶						
no.	no.	Ag	W	Ce	Nd	I	Sn	Comment
1	1-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	2-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	4-Lung	0.0	0.0	0.0	0.0	0.0	0.0	None
1	Avg.-Lung‖	0.0	0.0	0.0	0.0	0.0	0.0	-
2	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	Zr in Zr silicate
3	Tbb	0.0	0.0	0.0	0.0	0.0	0.0	
4	A-Lung	0.0	0.0	0.0	0.0	0.0	0.0	Al with P
4	B-Lung	0.0	0.0	0.0	0.0	0.0	0.0	FeCr; Al with P; Ti with P
4	Avg.-Lung‖	0.0	0.0	0.0	0.0	0.0	0.0	-
5	Lymphatic	0.0	0.0	0.0	0.0	0.0	0.0	Au with Cu; Al with Ti
8	Lymphatic	1.5	0.0	0.0	0.0	0.0	0.0	None
9	Tbb	0.0	0.0	0.0	0.0	0.0	0.0	
10	LN	0.0	0.0	0.0	0.0	0.0	0.0	

Table 6.6.5.1 Microscopic findings according to aircraft carrier assignment history, individuals with a hospital discharge diagnosis of sarcoidosis (ICD-9-CM Code 135), data from State University of New York (SUNY), Syracuse

	Findings of SUNY examination																					
Aircraft carrier assignment history	Granu-lomas		Necro-sis		Any particles		Partic. in gran's.		Endog. particles		Silica-like particles*		Opaque particles		Birefring. particles		C/W† TiO_2		C/W Talc		C/W sarcoidosis	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Carrier ($N = 9$)	6	3	2	7	5	4	2	7	0	9	2	7	2	7	2	7	2	7	0	9	4	5
Noncarrier ($N = 8$)	7	1	1	7	5	3	3	5	1	7	0	8	3	5	3	5	1	7	0	8	6	2
Total ($N = 17$)‡	13	4	3	14	10	7	5	12	1	16	2	15	5	12	5	12	3	14	0	17	10	7

	Odds ratios										
Odds ratio	Granu-lomas	Necro-sis	Any particles	Partic. in gran's.	Endog. particles	Silica-like particles*	Opaque particles	Birefring. particles	C/W TiO2	C/W Talc	C/W sarcoidosis
Carrier vs. noncarrier	**0.29**	**2.00**	**0.75**	**0.48**	**0.26**	**5.67**	**0.48**	**0.48**	**2.00**	-¶	**0.27**
p §	*0.58*	*1.00*	*1.00*	*0.62*	*1.00*	*0.47*	*0.62*	*0.62*	*1.00*	-¶	0.33
Lower 95% conf. limit	0.02	0.15	0.11	0.06	0.01	0.22	0.06	0.02	0.15	-¶	0.03
Upper 95% conf. limit	3.52	27.45	5.24	3.99	9.03	147.7	3.99	14.5	27.45	-¶	2.12

*Includes "possible" silica particles and those described as silica or silicates.

†C/W, consistent with.

‡SUNY reported microscopic features on one more sarcoidosis case than AFIP.

§Based on Fisher's Exact Test.

¶Statistic could not be calculated due to 2 cells containing zero.

(XL12, February 3, 2004 1:25 PM, v. 8.0J)

6.6.5.2. Stratified analysis of microscopic findings of silica-like particles, according to aircraft carrier assignment, individuals with a hospital discharge diagnosis of sarcoidosis ICD-9-CM Code 135), SUNY, 2002-2003*

A. Lung tissue

Aircraft carrier assignment history	No.	Silica-like particles Yes	No
Carrier	4	1	3
Noncarrier	6	0	6
Total	10	1	9

Odds ratio	
Carrier vs. noncarrier	5.57
p †	*0.40*
Lower 95% confidence interval	0.14
Upper 95% confidence interval	218.0

B. Lymphatic tissue

Aircraft carrier assignment history	No.	Silica-like particles Yes	No
Carrier	3	1	2
Non-carrier	2	0	2
Total	5	1	4

Odds ratio	
Carrier vs. non-carrier	3.00
p †	*1.00*
Lower 95% confidence interval	0.10
Upper 95% confidence interval	151.2

*This is a stratified analysis of 10 individuals who had lung parenchymal tissue available, and five individuals who had only lymphatic tissue available. Two individuals were excluded due to tissue that was neither lung parenchyma nor lymphatic. One had only bronchial tissue available, and the other had only nasal sinus mucosa and bone available.
†Based on Fisher's exact test.

(XL13, Feb. 3, 2004, 1:55 PM v. 1.1)

Table 6.6.6. Microscopic findings according to ship assignment history, individuals with a hospital discharge diagnosis of sarcoidosis (ICD-9-CM Code 135) SUNY, 2002-2003

	Findings of SUNY examination																					
Ship assignment history	Granu-lomas		Necro-sis		Any parts.		Parts. in gran's.		Endog. particles		Silica-like particles*		Opaque particles		Birefring. particles		C/W† TiO2		C/W Talc		C/W Sarcoid	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Any ship ($N = 14$)	10	4	2	12	8	6	4	10	1	13	2	12	3	11	4	10	2	12	0	14	8	6
No ship ($N = 3$)	3	0	1	2	2	1	1	2	0	3	0	3	2	1	1	2	1	2	0	3	2	1
Total ($N = 17$)	13	4	3	14	10	7	5	12	1	16	2	15	5	12	5	12	3	14	0	17	10	7

	Odds ratios										
Odds ratio	Granu-lomas	Necro-sis	Any parts.	Parts. in gran's.	Endog. particles	Silica-like particles*	Opaque particles	Birefring. particles	C/W TiO2	C/W Talc	C/W Sarcoid
Any ship vs. no ship	**0.33**	**0.33**	**0.67**	**0.80**	**0.78**	**1.40**	**0.14**	**0.80**	**0.33**	**0.24**	**0.67**
p ‡	*0.54*	*0.46*	*1.00*	*1.00*	*1.00*	*1.00*	*0.19*	*1.00*	*0.46*	§	*1.00*
Lower 95% Conf. Limit	0.00	0.02	0.05	0.06	0.00	0.00	0.01	0.06	0.02	§	0.0484
Upper 95% Conf. Limit	0.00	5.64	9.19	11.50	§	§	2.07	11.5	5.64	§	9.189

*Includes "possible" silica particles and those described as silica or silicates.

†C/W, consistent with.

‡Based on Fisher's exact test.

§Statistic could not be calculated due to one or more cells containing zero.

The SUNY findings were expanded to include all 29 individuals whose pathological material was examined by SUNY, regardless of diagnosis, in order to maximize sample size (**Table 6.6.7**). While there were no statistically significant associations, the trends for silica-like and birefringent particles were similar to those observed for the analysis that was limited to men with a hospital discharge diagnosis of sarcoidosis (**Table 6.6.5**).

When the data were stratified according to whether the tissue in the specimen was of lung or lymphoid origin, there were 4 individuals with a history of service aboard any type of ship and an equal number with no history of service aboard any type of ship who had lung parenchymal tissue available. Concentrations of titanium ($p = 0.04$) and aluminum ($p = 0.05$) were higher in the individuals who had a history of assignment aboard any type of Navy ship than in those with no shipboard assignment history. These results are shown in **Appendix Table 6**. There also were suggestive trends toward higher concentrations of total metals ($p = 0.11$), chromium ($p = 0.12$), and aluminum silicates ($p = 0.15$) in individuals who had a history of assignment to any type of ship. The sample size that was available was not large enough to allow statistical analysis with further stratification according to type of ship.

There was no statistically significant association between history of assignment to any type of ship and any light microscopic feature (**Table 6.6.8**). The trend for silica-like particles was considerably weaker than for the comparison with a history of assignment to an aircraft carrier, and the trend for birefringent particles was no longer present. Dilution of the trend may have occurred when all types of ships were combined, as in the analyses above.

These analyses were not able to identify the reason for the apparent divergence between the light microscopic findings by AFIP and those by SUNY. However, the apparent divergence is based on decisions regarding 2 individuals. This divergence is not statistically significant, and could be due to chance.

6.6.3 Additional SUNY SEM-EDXS data on nonmilitary specimens

The SUNY laboratory also provided for consideration and possible comparison the results of SEM-EDXS of pathological materials obtained from postmortem examinations of 19 nonmilitary individuals, mainly residents of New York counties, with a range of backgrounds and occupational histories (**Appendix Table 7**). No statistical procedures were performed of these supplementary data, but they are provided for use as needed and appropriate for comparison with other data for individuals of similar ages.

Table 6.6.7. Microscopic findings according to aircraft carrier assignment history, all individuals with light microscopic data, SUNY, 2002-2003

Aircraft carrier assignment history	Findings of SUNY examination																					
	Granu-lomas		Necro-sis		Any particles		Parts. in gran's.		Endog. particles		Silica-like particles*		Opaque particles		Birefring. particles		C/W† TiO2		C/W Talc		C/W Sarcoid	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Yes ($N = 10$)	7	3	2	8	6	4	3	7	0	10	3	7	2	8	2	8	3	7	0	10	5	5
No ($N = 19$)	15	4	4	14	9	10	5	14	2	17	2	17	5	14	4	15	3	16	0	19	12	7
Total ($N = 29$)	22	7	6	22	15	14	8	21	2	27	5	24	7	22	6	23	6	23	0	29	17	12

Aircraft carrier assignment history	Odds ratios										
	Granu-lomas	Necro-sis	Any particles	Parts. in gran's.	Endog. particles	Silica-like particles*	Opaque particles	Birefring. particles	C/W TiO2	C/W Talc	C/W Sarcoid
Yes vs. no	**0.62**	**0.88**	**1.67**	**1.20**	**0.33**	**3.64**	**0.70**	**0.94**	**2.29**	**1.86**	**0.58**
p ‡	*0.66*	*1.00*	*0.70*	*1.00*	*1.00*	*0.31*	*1.00*	*1.00*	*0.63*	§	*0.69*
Lower 95% CL¶	0.11	0.13	0.35	0.22	0.00	0.50	0.11	0.14	0.37	§	0.12
Upper 95% CL	3.56	5.89	7.88	6.53	§	26.8	4.48	6.3	14.3	§	2.75

*Includes "possible" silica particles and those described as silica or silicates.

†C/W, consistent with.

‡Based on Fisher's exact test.

§Statistic could not be calculated due to one or more cells containing zero.

¶CL, Confidence limit.

(XL15, Feb. 2, 2004, 4:10 PM v. 4.0J)

Table 6.6.8. Microscopic findings according to ship assignment history, all individuals with light microscopic data, SUNY, 2002-2003

	Findings of SUNY examination																					
Ship assignment	Granu-lomas		Necro-sis		Any particles		Parts. in gran's.		Endog. particles		Silica-like particles*		Opaque parts.		Biref. parts.		C/W† TiO_2		C/W Talc		C/W Sarcoid	
history	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Any ship ($N = 16$)	12	4	2	14	9	7	5	11	2	14	3	13	3	13	4	12	3	13	0	16	10	6
No ship ($N = 13$)	10	3	4	8	6	7	3	10	0	13	2	11	4	9	2	11	3	10	0	13	7	6
Total ($N = 29$)	22	7	6	22	15	14	8	21	2	27	5	24	7	22	6	23	6	23	0	29	17	12

	Odds ratios										
Odds ratio	Granu-lomas	Necro-sis	Any particles	Parts. in gran's.	Endog. particles	Silica-like particles*	Opaque parts.	Biref. parts.	C/W TiO_2	C/W Talc	C/W Sarcoid
Any ship vs. no ship	**0.90**	**0.29**	**1.50**	**1.52**	**4.66**	**1.27**	**0.52**	**1.83**	**0.77**	**0.82**	**1.43**
p ‡	*1.00*	*0.35*	*0.72*	*0.70*	*0.49*	*1.00*	*0.67*	*0.66*	*1.00*	§	*0.72*
Lower 95% conf. limit	0.16	0.04	0.34	0.29	0.02	0.18	0.09	0.28	0.13	§	0.32
Upper 95% conf. limit	5.01	1.92	6.53	8.03	11.83	9.02	2.90	12.1	4.65	§	6.32

*Includes "possible" silica particles and those described as silica or silicates.

†C/W, consistent with.

‡Based on Fisher's exact test.

§Statistic could not be calculated due to one or more cells containing zero.

7.0 CONCLUSIONS BASED ON PATHOLOGY

7.1 Availability

Despite an extensive search for extant pathological materials from Navy hospitals and the AFIP Repository, few suitable specimens were available for analysis (Section 4.3). Repeated contacts were made with all Navy hospitals, but samples for only 22 individuals could be located. These included samples from 13 individuals at Naval Hospital Portsmouth, 8 at San Diego, and 1 at Pensacola. Only 5 specimens from the Naval hospitals met the criteria for inclusion in the study, all from Naval Hospital Portsmouth.

The criteria for inclusion were established by the Joint Pathology Working Group, and are described in Section 5.2.1. They included a requirement that the tissue was either lung or lymphoid, not degraded beyond use, collected for diagnosis of a lung disease or a disease related to the lung, of adequate quantity for review and included a block or an unstained slide. In addition to the materials on 5 individuals received from Naval Hospital Portsmouth, material from 27 individuals was obtained from the AFIP Repository. When materials from all sources were combined, specimens were available for analysis from 32 individuals. AFIP examined specimens during 2002-2003 from 30 of these 32 individuals. A record of the original pathological diagnosis was available on 27 of these patients from DoD sources. The external laboratory (SUNY) examined duplicate samples of tissue from 28 of the 32 individuals. This limitation on available specimens occurred because pathology specimens are not stored by hospitals as a routine practice beyond a few years, and virtually all cases of sarcoidosis in this population were hospitalized many years ago.

7.2 Agreement on pathological characteristics

There was excellent agreement between AFIP and the external laboratory on whether the pathological material was consistent with sarcoidosis (Section 5.5.1). Specimens from 21 naval enlisted personnel were read by both AFIP and SUNY. AFIP read 14 as consistent with sarcoidosis, and SUNY read the same 14 as consistent with sarcoidosis, for 100% agreement. There were 5 individuals whose specimens AFIP read as consistent with sarcoidosis and SUNY read as not consistent, and 2 whose specimens AFIP read as consistent with sarcoidosis but SUNY disagreed. Overall agreement was 91%. This degree of agreement is recognized as excellent according to standard criteria for agreement between observers in medical fields (Landis, & Koch, 1977).

There was also reasonably good agreement between the hospital discharge diagnosis of sarcoidosis and the readings by the two laboratories. AFIP read specimens of 16 Navy enlisted personnel who had a discharge diagnosis of sarcoidosis while on active duty, and reported that specimens from 11 were consistent with sarcoidosis. This is 69% agreement. It is considered reasonable agreement because sarcoidosis largely is a clinical diagnosis, and factors other than the pathological findings play a major role in making the diagnosis. Still, it suggests the possibility that some individuals who did not have sarcoidosis may have been diagnosed as having it.

Agreement with the hospital discharge diagnosis was similar for the external laboratory. SUNY examined specimens from 17 Navy enlisted personnel who had a discharge diagnosis of sarcoidosis, and reported that specimens from 10 (59%) were consistent with sarcoidosis. This is also considered reasonable agreement for the reasons described above, but also suggests that sarcoidosis may have been overdiagnosed.

Agreement on pathological features was extremely high for characteristics such as presence of granulomas and necrosis. There was good agreement on other characteristics, with the possible exception of endogenous particles, which were not consistently classified compared with other pathological features. This apparent divergence between the 2 laboratories may reflect different criteria for identification of endogenous particles in the 2 laboratories.

7.3 Possible associations of ship assignment with pathological features

AFIP examined tissues from 16 Navy enlisted personnel with a hospital discharge diagnosis of sarcoidosis, including 8 who had a history of assignment aboard an aircraft carrier and 8 who had no known history of assignment to a carrier (**Table 6.6.1.1**). According to AFIP findings, particles were no more common in specimens from men who had been assigned aboard aircraft carriers than in those with no history of assignment to an aircraft carrier. The likelihood of silica-like particles, in particular, was the same in those with a history of assignment to an aircraft carrier and those with no know history of assignment aboard a carrier (OR = 1.0).

SUNY examined tissues from the 17 individuals with a Navy hospital discharge diagnosis of sarcoidosis, and found no statistically significant differences between the 2 subgroups (**Table 6.6.5.1**). Specifically, particles were slightly less likely to have been found in men with a history of assignment aboard an aircraft carrier (OR = 0.75) than in those who were never assigned to a carrier. Still, the OR for silica-like particles was very high, 5.67 (p = 0.47), suggesting that there may have been some degree of association between a history of assignment aboard an aircraft carrier and presence of silica-like particles in the lungs, which did not approach statistical significance. It is possible that the sample size may have been too small for an association to emerge as statistically significant.

A possible trend toward an association with birefringent particles also was present, but not statistically significant. Certain forms of birefringent particles are strongly suggestive of silica or silicates (Abraham, 1980; McDonald, & Roggli, 1995). The OR from the SUNY examination for birefringent particles was 5.0 (p = 0.46). This elevated OR suggests that there may have been some degree of association between a history of assignment aboard an aircraft carrier and presence of birefringent particles that did not emerge as statistically significant, possibly due to the limited sample size available. This might be parallel to the trend with silica-like particles. Although none of the differences between men with carrier and noncarrier histories based on data from either laboratory were statistically significant, this was the principal area where light microscopic findings from the 2 laboratories contrasted.

7.4 Mineralogical analyses

The mineralogical analyses by SEM-EDXS revealed very wide and intriguing variation in the quantitative mineral content of lung particles. In the AFIP analyses, silica was present in tissue from all but 1 of the patients whose specimens were examined, ranging in concentration from 3.6 to 235 million particles per cc. In the SUNY analyses, silica was present in the tissue from all but1individual, with concentrations ranging from 3.9 to 497 million particles per cc of tissue. Aluminum silicates were present in all but1individual whose tissues were examined by AFIP, with a range of 7.1 to 960 million particles per cubic centimeter. Aluminum silicates were present in all tissues examined by SUNY, ranging in concentration from 1.4 to 5.3 million particles per cubic centimeter. Titanium, aluminum, iron, miscellaneous silicates, talc, and other elements and minerals also were found in tissues from several individuals by both laboratories, but there was no statistically significant association of the concentrations with service aboard an aircraft carrier or other ship, possibly due to the limited sample size.

7.5 Summary of pathological findings and results

There have been vast technological advances in qualitative and quantitative techniques for mineralogical analyses and evaluation of exogenous particles in lung and lymphoid tissue in recent years. These advanced and sensitive techniques were applied to a limited number of available historical specimens in this study by 2 internationally recognized laboratories that worked independently. Their results were analyzed at a third laboratory using statistical techniques appropriate for testing inferences based on small sample sizes.

Perhaps due to limitations of statistical power and sample size, results from these laboratories did not identify a consistent set of pathological markers in lung or lymphoid tissue associated with history of service aboard aircraft carriers or other ships. The observation of the presence of early silicotic lesions or, possibly in latter cases, silicotic nodules, were not noted.

Epidemiological studies have identified an association between history of service aboard an aircraft carrier, and other ships, and an increased risk of a subsequent hospitalization for sarcoidosis. For this reason, analyses that compared specimens from individuals with a history of assignment on aircraft carriers or other ships with those of those with no such history could have resulted in identification of a characteristic set of pathological markers of an etiologic exposure. However, such a characteristic set of markers was not identified.

According to results from AFIP, the presence of silica-like particles was similar in lung and lymph node material from those with a history of assignment to an aircraft carrier to those with no known ship assignment history. By contrast, SUNY data suggested a possible association between history of aircraft carrier assignment and silica-like and birefringent particles. Such trends were absent when history of assignment to any type of ship was contrasted with no history of ship assignment. The absence of a trend toward higher particle concentrations in service members assigned to ships other than carriers could

possibly be interpreted as suggesting a dose-response effect in terms of the exposure thought to be most relevant (specifically, aircraft carrier service history). However, no statistical evaluation of this inference was possible since none of the trends were statistically significant and could have been due to chance.

Due to limitations of sample size, analyses of specimens by history of ship assignment necessitated grouping data from lung parenchyma, bronchial mucosa, and intrathoracic lymph nodes. Further subdivision of the data according to site of origin of the specimen was attempted, but this stratification reduced cell frequencies to a point where no further inferences were possible.

Although no further specimens could be identified in Navy MTFs after an extensive search, it is possible that availability of additional specimens from the period of interest could have resulted in identification of a consistent set of pathological markers associated with history of shipboard service. Identification of a set of such markers may not have been possible in the pathological study due to limited statistical power.

8.0 ADDITIONAL ANALYSES PERFORMED AT NHRC IN RESPONSE TO RECOMMENDATIONS FROM EXTERNAL REVIEWERS AND ADVISORY COMMITTEES

This section lists and describes additional analyses that were performed in response to comments from Dr. Han Kang, VA Epidemiologist, the Public Policy Advisory Committee, and the Joint Pathology Committee. The source of the comments is described below, along with a summary of the substance of the comment and the response provided by NHRC.

8.1. Veterans Administration

Dr. Han Kang, an epidemiologist from the VA, suggested that additional analyses of sarcoidosis incidence by ship service versus not serving aboard ship were necessary to meet1of the overall goals of determining if sarcoidosis is associated with service on Navy ships. In the case-control study, the analysis of aircraft carrier service history was limited to comparison of men with history of assignment aboard an aircraft carrier at any time in their naval career and those who had no known history of assignment to a carrier. The effect of service aboard other ships was therefore not fully evaluated.

> NHRC action taken: An analysis of risk of sarcoidosis in relationship to history of service aboard ship types other than aircraft carriers to determine the relationship to ship service, and to service aboard other ship types was conducted. 5 separate multivariate logistic regression models were used to determine the ORs for sarcoidosis associated with history of service aboard destroyers and escort ships, amphibious ships, destroyer tenders, and submarine tenders. The comparison population for each model included active-duty enlisted men with a history of service aboard any other type of ship or no ship service.

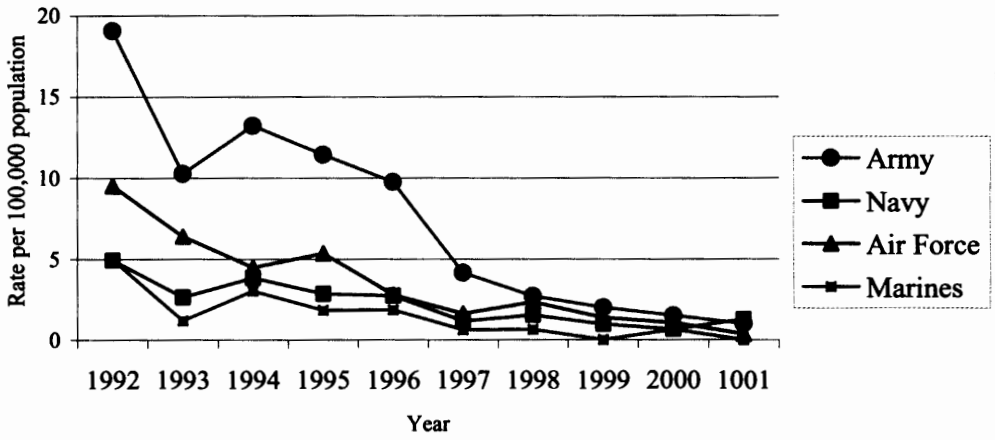
The period studied was from 1975 to 2001, when OBACs were available for use for ship classification. There were 841 cases with first admissions for sarcoidosis and 67,929 controls during this period. The OR associated with history of service aboard destroyers was 1.77 (95% CI, 1.38-2.26). The OR associated with history of service aboard amphibious ships was 1.18 (95% CI, 0.80-1.73). The OR associated with history of service aboard destroyer tenders was 1.86 (95% CI, 1.04-3.30). The OR associated with history of service aboard submarine tenders was 2.15 (95% CI, 1.34-3.45).

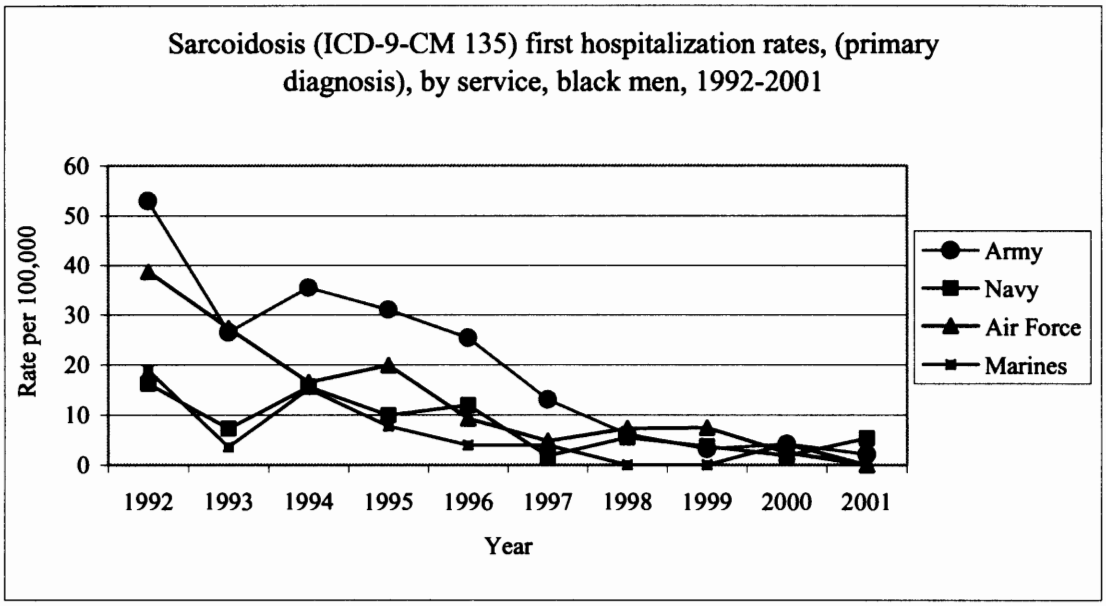
ORs also were adjusted using logistic regression for race, age at first hospitalization for sarcoidosis, date of entry to the Navy, age at entry to the Navy, history of service aboard an aircraft carrier, and home of record. After adjustment, none of the ORs remained statistically significant. The multiple-adjusted OR for sarcoidosis associated with assignment aboard destroyers was 1.25 (95% CI, 0.96-1.62). The OR for sarcoidosis associated with service aboard amphibious ships was 0.83 (95% CI, 0.56-1.23). The OR for sarcoidosis associated with service aboard destroyer tenders was 1.07 (95% CI, 0.59-1.95), and the OR associated with service aboard submarine tenders was 1.20 (95% CI, 0.73-1.95). For comparison, the multiple-adjusted OR associated with service aboard aircraft carriers during this period was 1.56 (95% CI, 1.33-1.83).

Dr. Han Kang also suggested that analyses of time trends in sarcoidosis incidence should be extended to the other services to help evaluate the question of whether an epidemic of sarcoidosis or other lung disease had occurred in the Navy.

NHRC action taken: The Tri-service Defense Medical Database was accessed to determine annual incidence rates for a primary hospital diagnosis of sarcoidosis among Army, Navy, Air Force, and Marine Corps active-duty men serving between 1992 and 2001. The highest incidence rates of sarcoidosis hospitalization occurred among Army servicemen during this time period among all men. A separate analysis was carried out for black servicemen serving during this time period. There was also a decline in incidence rates of hospitalization for sarcoidosis incidence in all the services in black men (please see figures below).

Sarcoidosis (ICD-9-CM 135) annual first hospitalization rates (primary diagnosis) by service, all men, 1992-2001





8.2 Public Policy Advisory Committee

Recommendations of the Public Policy Advisory Committee included:

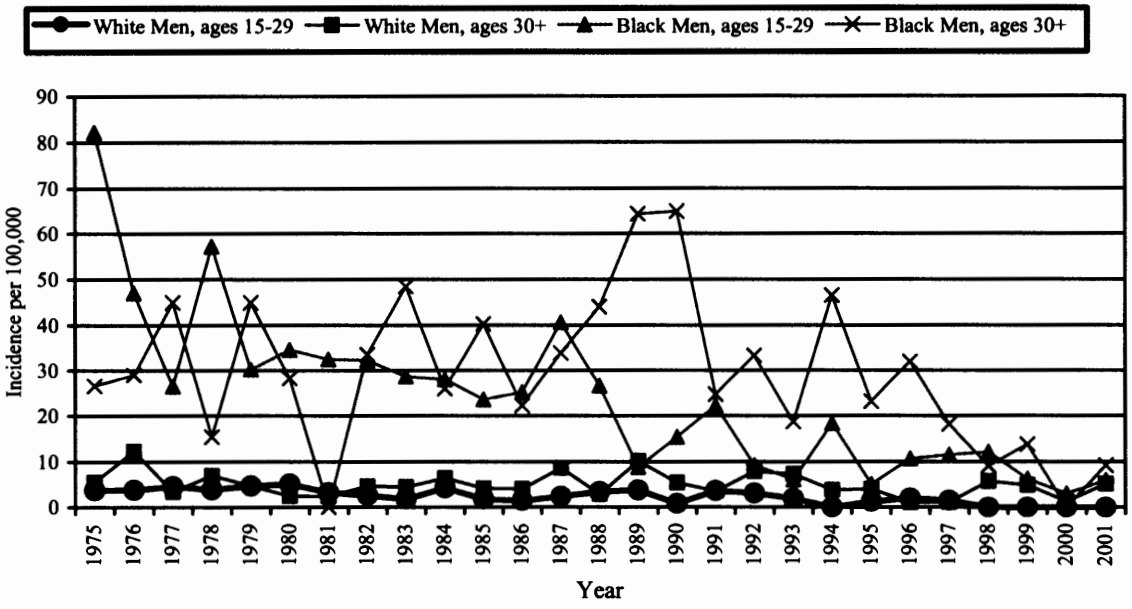
a. Expand the analysis of average annual incidence rates to include 1973 and 1974, if possible, since these early years are of great a priori interest, based on the previous CDC 1997 and Jajosky 1998 studies.

b. Stratify the yearly sarcoidosis incidence rates among blacks and whites by age group (i.e., 20-29, 30-39 years) and time frame (i.e., 1973-1977, 1978-1982), and displaying the resulting data in similar fashion to that of Figure 1, in the CDC 1997 incidence study, to facilitate data comparison and strengthen current conclusions.

c. In the x-ray policy analysis, provide yearly incidence rates from 1973 to 2001, superimposed on years of policy change.

   NHRC action taken: Age-specific annual incidence rates of sarcoidosis for U.S. Navy enlisted men stratified by race (white and black) and age group (15-29 years and 30+ years) were calculated and plotted for the years from 1975 to 2001. The results were similar, overall, to the figure in the CDC paper showing similar declining trends in incidence observed in both younger and older black men (please see figure below). The use of annual rates in this analysis provided a high resolution for detection of changes in temporal trends that was useful in considering the potential effects that changes in Navy radiographic TB screening policies may have had on incidence rates of sarcoidosis. It was not possible to obtain race-stratified population data for active-duty Navy enlisted personnel for the years 1973 and 1974.

Annual incidence rates of sarcoidosis for U.S. Navy enlisted men, by race, age group, and year, 1975-2001



8.2 Public Policy Advisory Committee Additional Analyses Requested (continued):

f. Provide race distribution information on the occupational codes that were associated with increased risk in both the incidence study and the case-control study.

NHRC action taken: Occupational analyses using standardized incidence ratios in the incidence study and occupation-specific ORs in the case-control study were stratified by race. In the incidence study, age-specific sarcoidosis incidence rates for all white or all black Navy enlisted men were applied to the occupation-specific populations at risk stratified by race (black or white) to yield age-adjusted, race-stratified standardized incidence ratios for 115 Navy enlisted occupations. This stratification technique directly controls for any effects on risk that differences that race distribution in specific occupations might contribute. In the case-control study, separate logistic models were run for whites and blacks. This stratification controls for any contribution of race to risk of sarcoidosis, and allows direct evaluation of risk associated occupation and duty station assignment. The race-specific logistic models in the case-control study found significant associations between period of entry into service, age, occupational group (rating), aircraft carrier history, and home of record on sarcoidosis risk in both white and black Navy enlisted men.

8.3 Joint Pathology Working Group

It was important to note that these results can document exposures to a mixture of agents that support the hypotheses of this study, but the analytical results cannot prove causation in a single case. Determination of causation must rely on standard epidemiological criteria. Criteria such as correctness of temporal association and biological plausibility are met by these results. (Item "G")

NHRC action taken: An estimation of latency period was undertaken to help address the criterion of temporal association referred to in this comment. Because exposure is difficult to define in terms of ship assignment or occupational group, and in order to make use of all cases, the approach to address the question of latency was to take the difference between date of entry into service and diagnosis date and calculate the median duration and interquartile range. This approach had the advantage of being conservative in the sense that it made no assumptions about ship-based exposure or occupational exposure. It had the statistical advantage of maximizing power by use of all the information that the cases could provide, since it did not exclude any cases based on what might be erroneous assumptions that exposure may have been limited to just 1 type of ship assignment or a particular occupational group. It is further based on the assumptions that no exposures occurred before initiation of Navy service and that no cases had sarcoidosis at service entry. This analysis of the time period between starting naval service and the first diagnosis of sarcoidosis among black and white Navy men found a median estimated latency of 5.6 years. The mean estimated latency was 7.7 with a standard deviation, 6.0 years (see table below).

Duration between initiation of naval service and first diagnosis of sarcoidosis (ICD-9-CM Code135) among black and white Navy men, 1965-2001.

75th percentile	11.4	Years
Median (50th percentile)	5.6	Years
25th percentile	3.0	Years
Interquartile range	8.4	Years
Shortest	11.0	Days
Longest	30.2	Years
Mean	7.7	Years
SD	6.0	Years

Based on 1,143 cases diagnosed during 1965-2001

9.0 STATEMENTS FROM ADVISORY COMMITTEES

Statements from the Advisory Committees are provided below.

9.1 Scientific Advisory Committee

The report of the Scientific Advisory Committee was as follows:

Overview. The purpose of the study was to try to determine if there was an excess risk of sarcoidosis among Navy servicemen exposed to dust from nonskid paint aboard Navy vessels. A two-pronged approach was taken to address this question. First, an epidemiological survey was undertaken that covered more than 10 million person-years of service and approximately 150 different occupational categories. Second, an effort was made to retrieve all available pathology from Navy personnel with a diagnosis of sarcoidosis and to analyze these specimens in 2 laboratories using state-of-the-art techniques for detecting foreign particulates in tissue samples.

Results: Epidemiology. The epidemiological survey showed a statistically increased risk for sarcoidosis among Navy personnel who were employed in 2 occupational categories with a high likelihood of exposure to dust from nonskid paint: Ships Servicemen and Aviation Structural Mechanics specializing in structures. No other categories showed a significantly increased risk for sarcoidosis. This observation was confirmed in a case-control study.

Results: Pathology. Among the approximately 1,200 Navy servicemen with a diagnosis of sarcoidosis while on active duty, tissue was retrieved for a disappointingly small number of cases. There were 25 individuals with a career history narrative. Of these 25 individuals, 18 had a hospital discharge diagnosis of sarcoidosis. The remaining 7 did not. For those who had a diagnosis, the ICD-9-CM diagnoses were: 465 Acute upper respiratory infections of multiple or unspecified site; 486 Pneumonia, organism unspecified; and 518.3 Pulmonary eosinophilia. 4 of the 7 were never hospitalized while in the Navy.

Pathological materials from 11 people were analyzed both by AFIP and by Dr. Abraham's lab at SUNY. When particles were found, and analyzed, they were, for the most part, silica, aluminum silicates, and various metals. Some unusual particles were found among the materials, including uranium and iridium. 7 additional cases of sarcoidosis in the high-risk groups had previously been analyzed in Dr. Abraham's laboratory and reported in abstract form. Biopsies showing granulomatous inflammation in lung or lymph nodes consistent with sarcoidosis were available in 21 pathological materials, including 3 with high-risk occupations (2 of which are from Dr. Abraham's prior study) and 18 with other occupations.

Critique. The epidemiological studies suggest a couple of likely explanations that cannot be distinguished by present information. One is that there are a number of cases of pneumoconiosis resulting from exposure to nonskid paint that have been misdiagnosed as

sarcoidosis. Another is that there is a subset of the population with a heightened susceptibility to sarcoidosis that is activated by exposure to some component of nonskid paint. A third possibility is that the findings are a matter of chance. The latter seems to have been unlikely since the increased risk was only identified in groups with the exposures suspected of causing disease.

The pathological findings at the SUNY laboratory showed a modest, statistically nonsignificant increase in particulate content among people who had a history of assignment to an aircraft carrier (OR = 1.33, p = 1.00). AFIP did find this (OR = 0.2, p = .31).

The SUNY laboratory found a modest, not statistically significant increase in birefringent particles (OR = 7.5, p = 0.24). The findings, for birefringent particles, were exactly the opposite for AFIP (OR = 0.09, p = 0.12).

The SUNY laboratory also found an increase in silica-like particles in people who had a history of service aboard an aircraft carrier (OR = 6.43, p = 0.36). AFIP found exactly the opposite association (OR = 0.44, p = 1.00).

The types of particulates identified were for the most part the types found in individuals from the general population, with the exception of a few unusual particles as noted above. The levels of talc and aluminum silicates identified were less than that typically associated with pneumoconiosis, and none of the cases had silicotic nodules. Some cases appeared to have infectious diseases (mycobacterial or fungal). The metals that were present in increased levels were Fe, Ti, Al, and Cr. The metals that are characteristic of non-skid paint are Al, Zr, Ti, W, and Co. The particulates identified may not be the cause but rather a marker for some other agent that is the cause of the granulomas.

Recommendations. The objectives of the study have been met. Epidemiological studies show a nonsignificant trend in the SUNY data toward increased particles in tissue from personnel who had a history of assignment aboard an aircraft carrier. However, the findings were diametrically opposed in the AFIP data. This was not a direct comparison because only 11 of the 18 specimens from active-duty Navy personnel who had a hospital discharge diagnosis of sarcoidosis were examined in common by the 2 laboratories. It is possible that SUNY may have analyzed a biased subset of the pathological materials.

Despite the major inconsistency of the findings of particles between the 2 laboratories, further investigation of historical exposures might be useful. Components of nonskid paint have been identified in some tissue samples that were analyzed by SEM-EDXA. In order to further understand the observations = , the following additional studies are suggested:

1. Perform SEM-EDXA analysis of the granulomas themselves for concentration and types of particulates, comparing the results for individuals with high likelihood of exposure to nonskid paint with those with a lower risk of exposure.
2. Attempt to obtain additional samples of tissue from Navy personnel with a tissue diagnosis of sarcoidosis from private hospitals (coordinated with the Public Policy Advisory Board).

3. Obtain detailed exposure histories on cases with documented non-necrotizing granulomatous inflammation in lung and lymph nodes for which particle analyses have been performed (detailed occupational histories have been obtained for individuals with a career history available.)

4) Evaluate Navy personnel with sarcoidosis in high exposure categories by external review board for accuracy of diagnosis and the presence of disability.

9.2 Public Policy Advisory Committee

The report of the Public Policy Advisory Committee is as follows:

1. The following are positive outcomes of the epidemiological studies:

   a. The 27-year historical prospective incidence study has shown that over the 1975-2001 period, the average annual incidence rates for a hospital diagnosis of sarcoidosis declined substantially among black Navy enlisted men, while incidence rates for white Navy enlisted men were relatively stable, confirming the findings of the CDC 1997 incidence study for the time period 1971-1993.

   b. The incidence study also demonstrated significantly increased risk for a hospital diagnosis of sarcoidosis among black Ships Servicemen (SIR 2.3*), black Aviation Structural Mechanics (SIR 2.1*), and white Mess Management Specialists (SIR 2.0*). (Asterisks denote statistically significant ORs.)

   c. The nested case-control study has demonstrated highly statistically significant ($p < 0.001$) increased risk for a diagnosis of sarcoidosis among ships servicemen (OR= 2.3*) and aviation ratings as a group (OR=1.8*), after controlling for age, race, date of Navy entrance, home of record, and history of service aboard an aircraft carrier.

2. In order to gain more information from the data reported herein, we recommend the following:

   a. Expanding the analysis of average annual incidence rates to include 1973 and 1974, if possible, since these early years are of great a priori interest, based on the previous CDC 1997 and Jajosky 1998 studies (Done.)

   b. Stratifying the yearly sarcoidosis incidence rates among blacks and whites by age group (i.e., 20-29, 30-39) and time frame (1973-1977, 1978-1982), and displaying the resulting data in similar fashion to that of Figure 1, in the

CDC 1997 incidence study, to facilitate data comparison, and strengthen current conclusions. (Done.)

c. In the Navy mass radiological screening policy analysis, providing yearly incidence rates from 1973 to 2001, superimposed on years of policy change. (Done.)

d. Attempting to secure additional histopathological specimens from Navy sarcoidosis cases, as well as age- and era-matched Navy controls. (Done.)

e. Considering the incorporation of 6 Navy cases, referred by Reverend Cochran and evaluated by Drs. Abraham and Panitz (2001), in the current pathology study, followed by an independent quantitative SEM-EDXA particle analysis at AFIP and SUNY. (This was not possible within the study design since these specimens could not be blinded on a practical basis.)

f. Providing race distribution information on the occupational codes that were associated with increased risk in both the incidence study and the case-control study (Done).

3. Based on the results above, the Public Policy Advisory Committee recommends that:

a. U.S. government officials should:
   i. Notify the individuals whose tissues were evaluated in this study of the findings from their pathology reviews and particle analyses,
   ii. Apprise them of the findings from the incidence and case-control studies.

b. U.S. government officials should notify all government personnel who have worked aboard U.S. military ships and *acquired a diagnosis of "sarcoidosis"* that U.S. government medical personnel will conduct free medical evaluations to better clarify their lung disease if:
   i. They know or suspect they were exposed to dusts, such as those generated by deck-grinding, while aboard ship,
   ii. They have not fully recovered from their lung disease.

c. U.S. government officials should notify all government personnel who have worked aboard U.S. military ships, that U.S. government medical personnel will conduct free medical evaluations to detect dust-induced lung disease, if:
   i. They know or suspect they were exposed to dusts, such as those generated by deck-grinding, while aboard ship,
   ii. They have acquired chronic respiratory symptoms without known cause.

d. As part of such medical evaluations, any prior lung and/or lymph node biopsies should be recovered for histologic and SEM-EDXA evaluation by AFIP and SUNY.

e. These medical evaluations should entail history-taking by a qualified occupational or lung disease specialist; chest x-rays interpreted by a qualified B-reader; tissue biopsy (when indicated) read by a qualified pathologist; and SEM-EDXA analysis (when indicated) by a qualified specialist at AFIP or SUNY.

f. These health communications and outreach efforts are standard public health approaches that are essential in:
    i. Utilizing knowledge gained from this occupational sentinel health event of "sarcoidosis" among dust-exposed shipboard servicemen,
    ii. Optimizing the health care of coworkers with similar exposures who may have developed similar dust-induced lung disease,
    iii. Identifying the exact etiology of this dust-induced lung disease, both for individuals and for groups of exposed personnel,
    iv. Developing an approach to primary prevention of dust-induced lung disease in the U.S. military services.

g. These public health communications and outreach efforts must be promulgated *in a timely fashion*, to minimize the suffering of exposed workers and their families, and to prevent the loss of vital medical evidence concerning this preventable work-related disease.

h. We recommend follow-up and future directions, including:
    i. The development and maintenance of a registry of affected Navy personnel through notification to the NHRC database of sarcoidosis among active duty personnel (1,162) and the VA sarcoidosis/pneumoconiosis database (about 1,000 Navy personnel).
    ii. Solicitation of funding by private and academic institutions for the purpose of seeking out affected individuals through community efforts.

Congressional mandate of appropriate funding, in order to accomplish the above recommendations.

10.0 BIBLIOGRAPHY

Abraham JL. Microanalysis of Human Granulomatous Lesions. Proceedings 8th International Conference on Sarcoidosis, edited by W. Jones Williams and B.H. Davies. Alpha Omega Publishing, Ltd., Cardiff, 1980, pp. 38-46.

Abraham JL, (name) BR. Quantitative analysis of inorganic particulate burden in situ in tissue sections. Scanning Electron Microscopy 1983; 2:681-696, 1983.

Abraham JL, Burnett BR, Hunt A. Quantification of non-fibrous and fibrous particulates in human lungs: Twenty year update on pneumoconiosis database. Ann Occup Hyg 46 (Suppl. 1): 397-401, 2002.

Abraham JL, Newman LS, Burnett BR. Beryllium disease: pathologic and quantitative electron probe and secondary ion mass spectroscopic (SIMS) analyses of lung biopsies. Am J Resp Crit Care Med 151:A712, 1995.

Abraham JL, Panitz E. Is "Sarcoidosis" in the US Navy occupational lung disease from the grinding of non-skid paint aboard aircraft carriers? Analysis of inorganic particulates in lungs and a reference paint sample. Am J Resp Crit Care Med 2001; 163;A214.

American Thoracic Society. Statement on sarcoidosis. Am J Respir Crit Care Med 1999;160(2):736-755.

Armbruster C, Dekan G, Hovorka A. Granulomatous pneumonitis and mediastinal lymphadenopathy due to photocopier toner dust. Lancet 1996;348:690.

Armitage P, Berry G. Statistical methods in medical research. 3rd ed. London: Blackwell, 1994.

Badrinas F. Morera J, Fite E, Plasencia A. Seasonal clustering of sarcoidosis. Lancet 1989;ii:455-6.

Blobstein SH, Weiss HD, Myskowski PL Sarcoidal granulomas in tattoos. Cutis 1985;36:423-424.

Bresnitz EA, Stolley PD, Israel HL, Soper K. Possible risk factors for sarcoidosis: a case-control study. Ann N Y Acad Sci 1986;465:632-642.

Bresnitz EA, Strom BL. Epidemiology of sarcoidosis. Epidemiol Rev 1983;5:124-56.

Centers for Disease Control and Prevention. Sarcoidosis among U.S. Navy enlisted men, 1965-1993. MMWR Morb Mortal Wkly Rep 1997;46:539-43.

Cohen J. A coefficient of agreement for nominal scales. Educ Psychol Meas 1960;20:37.

Connolly JP, Baez SA. Asthma in the Navy and Marine Corps. Mil Med 1991;156:461-5.

Cooch JW. Sarcoidosis in the U.S. Army, 1952 through 1956. Am Rev Respir Dis 1961;84 (Suppl):103-8.

Cummings MM, Dunner E, Williams JH Jr. Epidemiologic and clinical observations in sarcoidosis. Ann Intern Med 1959;50:879-90.

Cummings MM, Dunner E, Schmidt H Jr, Barnwell JB. Concepts of epidemiology of sarcoidosis. Postgrad Med 1956;19:437-46.

DeVuyst P, Dumortier P, Schandene L, Estenne M, Verhest A, Yernault JC. Sarcoidlike lung granulomatosis induced by aluminum dusts. Am Rev Respir Dis 1987;135:493-497.

Drent M, Bomans PH, Van Suylen RJ, Lamers RJ, Bast A, Wouters EF. Association of man-made mineral fibre exposure and sarcoid-like granulomas. Respir Med 2000; 94:815-820

Edmonstone WM. Sarcoidosis in nurses: is there an association? Thorax 1988;43:342-343.

Fanburg BL. Sarcoidosis (1996). In: Bennett JC, Plum F, eds. Cecil textbook of medicine. Philadelphia: WB Saunders:431-436.

Fanburg BL, Lazarus DS. Sarcoidosis. In: Murray JF, Nadel JA, eds. Textbook of Respiratory Medicine, 2nd ed. Philadelphia: Saunders; 1994:1873-88.

Fleiss JL. Statistical methods for rates and proportions, 3rd ed. New York: John Wiley & Sons, 2003.

Forst LS, Abraham JL. Hypersensitivity pneumonitis presenting as sarcoidosis. Br J Ind Med, 1993 50:497-500.

Garland FC, Gorham ED, Garland CF. Hodgkin's disease in the U.S. Navy. Int J Epidemiol 1987;16:1-6.

Garland FC, Gorham ED, Cunnion SO, Miller MR, Balazs LL, and the Navy HIV Working Group. Decline in human immunodeficiency virus seropositivity and seroconversion in U.S. Navy enlisted personnel: 1986 to 1989. Am J Public Health 1992;82:581-4.

Garland FC, Gorham ED, Garland CF. Non-Hodgkin's lymphomas in U.S. Navy personnel. Arch Environ Health 1988;43:425-9.

Garland FC, Garland CF, Doyle EJ, Balazs L, Levine R, Pugh W, Gorham ED. Carpal tunnel syndrome and occupation in U.S. Navy enlisted personnel. Arch Environ Health 1996;51:395-407.

Garland FC, Gorham, ED, Garland CF, Ducatman AM. Testicular cancer in U.S. Navy aircraft and engine maintenance personnel. Am J Epidemiol 1988;127:411-4.

Garland FC, Shaw E, Gorham ED, Garland CF, White MW, Sinsheimer PJ. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy Personnel. Am J Epidemiol 1990;132:293-303.

Garland FC, White MW, Garland CF, Shaw EK, Gorham ED. Occupational sunlight exposure and melanoma in the U.S. Navy. Arch Environ Health 1990;45:261-7.

Gentry JT, Nitowsky HM, Michael M Jr. Studies on the epidemiology of sarcoidosis in the United States: the relationship to soil areas and to urban/rural residence. J Clin Invest 1955;34:1839-56.

Gibbs AR, Wagner JC. Diseases due to silica. In: Churg A, Green FHY. Pathology of occupational lung disease. Philadelphia: Lippincott, 1998.

Gorham ED, Garland FC, Barrett-Connor E, Garland CF, Wingard DL, Pugh W. Incidence of insulin-dependent diabetes mellitus in young adults: experience of 1,587,630 US Navy enlisted personnel. American Journal of Epidemiology 1993;138:1-4.

Gundelfinger BF, Britten SA. Sarcoidosis in the U.S. Navy. Am Rev Respir Dis 1961;84 (Suppl):109-15.

Gunderson EKE, Garland CF. Health surveillance of asthma in the US Navy: Experience of 4,809,422 person-years. Naval Health Research Center Technical Report No. 02-09. San Diego: Naval Health Research Center, 2002.

Gunderson EKE, Miller MR, Garland CF. Career History Archival Medical and Personnel System (CHAMPS): Data resource for cancer, chronic disease, and other epidemiological research. Naval Health Research Center Technical Report No. 02-06. San Diego: Naval Health Research Center, 2002.

Henke CE, Henke G, Elveback LR, Beard CM, Ballard DJ, Kurland LT. The epidemiology of sarcoidosis in Rochester, Minnesota: a population-based study of incidence and survival. Am J Epidemiol 1986; 123: 840-45.

Hennessy TW, Ballard DJ, DeRemee RA, Chu CP, Melton LJ. The influence of diagnostic access bias on the epidemiology of sarcoidosis: a population-based study in Rochester, Minnesota, 1935-1984. J Clin Epidemiol 1988;41:565-70.

Hull MJ, Abraham JL. Aluminum welding fume-induced pneumoconiosis. Hum Pathol 2002 Aug;33(8):819-25.

International Classification of Diseases, Ninth Revision, Clinical Modification, 6th ed. Salt Lake City: Medicode, 2000.

Israel HL. Influence of race and geographical origin on sarcoidosis. Arch Environ Health 1970;20:608-10.

Jajosky P. Sarcoidosis diagnoses among US military personnel: trends and ship assignment associations. Am J Prev Med 1998;14:176-83.

James DG. Epidemiology of sarcoidosis. Sarcoidosis 1992;9:79-87.

James DG, Turiaf I, Hosoda Y. Description of sarcoidosis: report of the Subcommittee on Classification and Definition. Ann N Y Acad Sci 1976;278:742.

Jones MS, Maloney ME, Helm KF. Systemic sarcoidosis presenting in the black dye of a tattoo. Cutis 1997; 59:113-115.

Kajdasz DK, Judson MA, Mohr LC, Lackland DT. Geographic variation in sarcoidosis in South Carolina: its relation to socioeconomic status and health care indicators. Am J Epidemiol 1999;150:271-8.

Kajdasz, DK, Lackland DT, Mohr LC, Judson MA. A current assessment of rurally linked exposures as potential risk factors for sarcoidosis. Ann Epidemiol 2001;11:111-7.

Katz S. Clinical presentation and natural history of sarcoidosis. In: Fanburg BL, ed. Sarcoidosis and other granulomatous diseases of the lung. New York: Marcel Dekker; 1983:3-36.

Keller AZ. Anatomic sites, age attributes, and rates of sarcoidosis in US veterans. Am Rev Respir Dis 1973;54:87-98.

Keller AZ. Hospital, age, racial, occupational, geographical, clinical and survivorship characteristics in the epidemiology of sarcoidosis. Am J Epidemol 1971;94:222-30.

Kern DG, Neill MA, Wrenn DS, Varone JC. Investigation of a unique time-space cluster in firefighters. Am Rev Respir Dis 1993;148:974-80.

Kim YC, Triffet MK, Gibson LE. Foreign bodies in sarcoidosis. Am J Dermatopathol 2000; 22:408-12.

Kirkwood B, Sterne JAC. Essential medical statistics, 2nd ed. London: Blackwell, 2003.

Kotter JM, Zieger G. Sarcoid granulomatosis after many years of exposure to zirconium, "zirconium lung." Pathologe 1992;13:104-9.

Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159.

Lilienfeld DE, Stolley PD. Foundations of epidemiology, 3rd ed. New York: Oxford, 1994: 303.

McDonald J, Roggli V. Detection of silica particles in lung tissue by polarizing light microscopy. Arch Pathol Lab Med 1995;119:242-6.

McDonough C, Gray GC. Risk factors for sarcoidosis hospitalization among U.S. Navy and Marine Corps personnel, 1981 to 1995. Mil Med 2000;165:630-2.

Newman LS, Kreiss K, King TE, Seay S, Campbell PA. Pathologic and immunologic alterations in early stages of beryllium disease: re-examination of disease definition and natural history. Am Rev Respir Dis 1989;139:1479-86.

Parkes SA, Baker SB, Bourdillon RE, Murray CR, Rakshit M, Sarkies JW, Travers JP, Williams EW. Incidence of sarcoidosis in the Isle of Man. Thorax 1985;40:284-287.

Pesola GR, Kurdi M, Olibrice M. Endobronchial sarcoidosis and hyperreactive airways disease. Chest 2002;121:2081.

Pimentel JC. Systemic granulomatous disease, of the sarcoid type, caused by inhalation of titanium dioxide. Anatomo-clinical and experimental study. Acta Med Port 1992;5:307-13.

Prezant DJ, Dhala A, Goldstein A, Janus D, Ortiz F, Aldrich TK, Kelly KJ. The incidence, prevalence, and severity of sarcoidosis in New York City firefighters. Chest 1999 Nov;116:1183-93.

Rafnsson V, Ingimarsson O, Hjalmarsson I, Gunnarsdottir H. Association between exposure to crystalline silica and risk of sarcoidosis. Occup Environ Med 1998;55:657-62.

Redline S, Barna BP, Tomashefski JF, Jr, Abraham JL. Granulomatous disease associated with pulmonary deposition of titanium. Br J Indian Med 1986;43:652-656.

Rybicki BA, Major M, Popovich J Jr, Maliarik MJ, Iannuzzi MC. Racial differences in sarcoidosis incidence: a 5-year study in a health maintenance organization. Am J Epidemiol 1997;145:234-41.

Sartwell PE, Edwards LB. Epidemiology of sarcoidosis in the US Navy. Am J Epidemiol. 1974;99:250-7.

Sharma OP, Bijwadia J. Monitoring and treating sarcoid lung disease. J Respir Dis 1993;14:750-760.

Siltzbach LE. Geographic aspects of sarcoidosis. Trans N Y Acad Sci. 1967;29:364-74.

Skelton HGD, Smith KJ, Johnson FB, Cooper CR, Tyler WF, Lupton GP. Zirconium granuloma resulting from an aluminum zirconium complex: a previously unrecognized agent in the development of hypersensitivity granulomas. J Am Acad Dermatol 1993;28:874-876.

Travis WD, Colby TV, Koss MN, Rosado-de-Christensen ML, Müller NL, King TE. Atlas of nontumor pathology, non-neoplastic disorders of the lower respiratory tract, Armed Forces Institute of Pathology, American Registry of Pathology, Washington DC, 2002.

Visscher D, Churg A, Katzenstein AL. Significance of crystalline inclusions in lung granulomas. Mod Pathol 1988;1:415-9.

Yamamoto M, Sharam OP, Hosoda Y. The 1991 descriptive definition of sarcoidosis. Sarcoidosis 1992; 9(suppl 1):S33-34.

11.0 Appendix Tables

Appendix Table 1. Side-by-side comparison of AFIP and SUNY SEM-EDXA results, analysis provided by AFIP*

ID no.	Sample	AFIP no.	Total fields		Particles analyzed		Total particles		Exogenous particles, concentration in millions/cm^3									
									Silica		Alum. silicates		Talc		Misc. silicates		Total metals	
			AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY
1	-	1401249	Qualitative data only available from AFIP.†															
2	-	1657849	150	150	21	27	74.7	2.1	67.6	nd‡	7.1	1.4	0	0	0	0	0	0.7
3	-	1640288	Block exhausted, failed transfer to the carbon disk.															
4	A	1706782	150	200	29	114	103.2	66.9	96.1	11.3	0	9.0	0	0	3.6	0	3.6	46.6
"	B	1706782	150	143	71	252	252.7	217.0	32.0	85.9	217.1	66.3	0	0	-	12.1	3.6	52.6
5	-	1989975	100	150	66	139	352.9	149.2	48.1	59.3	187.2	64.9	10.7	nd	21.4	nd	85.5	25.0
6		9272	No data provided.															
7	-	1865231	150	-	5	-	17.8	-	3.6	-	7.1	-	-	-	3.6	-	3.6	-
8	-	2304870	100	200	12	52	64.2	27.3	0	13.9	10.7	7.7	0	1.0	0	0	53.5	4.6
9	-	2268634	120	-	3	-	13.6	-	13.6	-	-	-	-	-	-	-	-	-
10	A	2271666§	150	-	4	-	14.2	-	3.5	-	10.7	-	-	-	0	-	0	-
"	B	2271666	42	-	104	-	1324.8	-	254.8	-	789.8	-	-	-	242.0	-	38.2	-
"	C	2271666	60	-	106	-	1428.6	-	215.6	-	1131	-	-	-	27.0	-	54.3	-
11	-	2318553	No carbon disk at AFIP.															
12	A	2392516	55	50	100	193	970.9	328.4	203.9	360.3	271.9	61.7	19.4	nd	106.8	44	368.9	162.4
"	B	2392516	150	50	55	187	195.7	1032	10.7	497.4	35.6	332.9	59.9	nd	42.7	59.8	49.9	102.9
13	-	2456959	No carbon disk at AFIP. Histo lab couldn't tranfer the tisue from slides to carbon disk.															

Appendix Table 1. Side-by-side comparison of AFIP and SUNY SEM-EDXA results, analysis provided by AFIP*

ID no.	Sample	AFIP no.	Total fields		Particles analyzed		Total particles		Exogenous particles, concentration in millions/cm^3									
									Silica		Alum. silicates		Talc		Misc. silicates		Total metals	
			AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY	AFIP	SUNY
14		5643	No data provided.															
15	-	2578424	No carbon disk at AFIP.															
16	A	2838850	-	150	-	39	-	56.1	-	14.2	-	4.1	-	20.0	-	15.9		1.4
"	B	2838850	SEM could not read the disk.															
17	-	2841280	100	80	94	148	507.1	323.1	116.7	187.0	208.6	67.7	5.34	nd	79.9	38.1	101.6	30.3
18	-	2839113	¶	55	-	151	-	174.0	-	95.7	-	78.3	-	0	-	nd		nd
19	-	2840746	100	150	62	83	331.5	62.9	101.6	22.1	176.5	35.3	0	0	16.0	2.2	37.4	1.1
20	-	2840567	200	200	27	23	72.1	17.4	16.0	4.1	32	5.8	5.34	0.8	0	0	18.7	6.6
21	-	1338816	Mercury contaminated.															
22‖	-	1754427	Mercury contaminated.															

*Source: Dr. Jose Centeno, Armed Forces Institute of Pathology.

†AFIP provided only qualitative analysis of pathological material from this individual. The qualitative analysis revealed Si, Mg, Al, Ti, U, Zn, I, Cu and In particles. Further information is available from AFIP.

‡Abbreviation nd, none detected.

§Fat tissue, hard to see and collect data under SEM

¶This material was not examined by AFIP. AFIP requested a new carbon disk from the Histology Laboratory on 8/7/03.

‖No comparative analysis was provided concerning individuals with ID nos. 22-32.

Appendix Table 2. Summary of light microscopic features, AFIP, 2002-2003

ID no.	Sex	Race	Adm. year	Age	Consist. with sarcoidosis? AFIP	Consist. with sarcoidosis? SUNY	Diagnosis	Aircraft carr.his. C*	Aircraft carr.his. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	AFIP report: Granulomas?	AFIP report: Necrosis?	AFIP report: Endogenous part's?	AFIP report: Schaumann bodies?	AFIP report: Any particles?	AFIP report: Silica-like particles?	AFIP report: Polarizing part's.?	AFIP no.
1	M	N	1971	24	No	No	Sarcoid	No	No	No	No	Lung	Yes	Yes	Yes	No	Yes	No	Yes	1249
2	M	N	1978	22	Yes	Yes	Sarcoid	No	No	Yes	Yes	Lymph	Yes	Yes	No	No	No	No	No	7849
3	M	N	1978	35	Yes	Yes	Sarcoid	No	No	Yes	Yes	Lung	Yes	No	No	No	Yes	No	No	0288
4	M	N	1975	35	No	No	Sarcoid	No	No	Yes	Yes	Lung	No	No	No	No	No	No	No	6782
5	M	C	1980	24	Yes	No	Sarcoid	Yes	Yes	No	No	Lymph	Yes	No	No	No	Yes	No	No	9975
6	F	N	1982	30	Yes	.	Pulm. Eos.	.	No	No	No	Lung	Yes	No	Yes	No	No	No	No	9272
7	M	N	1971	18	Yes	Yes	Pneumonia	.	No	No	No	Lymph	Yes	Yes	No	No	No	No	No	5231
8	M	N	1990	24	Yes	Yes	Sarcoid	No	No	No	No	Lymph	Yes	Yes	No	No	No	No	Yes	4870
9	M	C	.	.	Yes	Yes	No hosp.	.	No	No	No	Lung	Yes	Yes	Yes	No	Yes	No	No	8634
10	M	C	1970	19	Yes	Yes	URI	.	No	No	No	Lymph	Yes	No	No	No	Yes	No	Yes	1666
11	M	C	1991	37	Yes	Yes	Sarcoid	No	No	Yes	Yes	Lung	Yes	Yes	No	No	Yes	Yes	Yes	8553
12	M	N	1992	26	Yes	Yes	Sarcoid	No	No	Yes	Yes	Lung	Yes	No	No	No	Yes	No	Yes	2516
13	M	C	1984	30	Yes	Yes	Sarcoid	Yes	Yes	Yes	Yes	Lung	Yes	No	Yes	Yes	Yes	Yes	Yes	6959
14	F	.	.	.	Yes	.	No hist.	.	No	.	No	Lung	Yes	No	No	No	No	No	No	5643
15	M	N	1996	28	Yes	Yes	Sarcoid	Yes	Yes	Yes	Yes	Lymph	Yes	Yes	No	No	No	No	No	8424

Appendix Table 2. Summary of light microscopic features, AFIP, 2002-2003

ID no.	Sex	Race	Adm. year	Age	Consist. with sarcoidosis? AFIP	Consist. with sarcoidosis? SUNY	Diagnosis	Aircraft carr.his. C*	Aircraft carr.his. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	AFIP report: Granulomas?	Necrosis?	Endogenous part's?	Schaumann bodies?	Any particles?	Silica-like particles?	Polarizing part's.?	AFIP no.
16	M	.	.	.	No	No	No hist.	.	No	.	No	Lung	No	No	No	No	Yes	No	No	8850
17	M	.	.	.	No	No	No hist.	.	No	.	No	Bronchi	No	No	No	No	No	No	No	1280
18	M	.	.	.	No	No	No hist.	.	No	.	No	Lung	Yes	Yes	No	No	Yes	Yes	Yes	9113
19	F	.	.	.	No	No	No hist.	.	No	.	No	Lymph	Yes	Yes	No	No	No	No	No	0746
20	F	.	.	.	No	No	No hist.	.	No	.	No	Lung	Yes	Yes	No	No	No	No	No	0567
21	M	C	1970	24	Yes	Yes	Sarcoid	No	No	No	No	Lung	Yes	No	Yes	Yes	Yes	No	Yes	0816
22	M	N	1980	29	No	No	Sarcoid	No	Yes	No	No	Lung	No	No	No	No	No	No	No	4427
23	F	N	1983	26	.	.	Sarcoid	No	No	No	No	Lymph	.	.	.	.	.	.	.	0075
24	M	N	.	.	Yes	Yes	No hosp.	.	No	Yes	Yes	Bronchi	Yes	No	Yes	No	No	No	Yes	9153
25	M	C	.	.	Yes	Yes	No hosp.	.	No	No	No	Lymph	Yes	No	No	No	Yes	Yes	Yes	2418
26	M	N	.	.	Yes	Yes	No hosp.	.	Yes	Yes	Yes	Lung	Yes	Yes	Yes	No	Yes	No	Yes	5453
27	M	N	1995	37	.	Yes	Sarcoid	Yes	Yes	Yes	Yes	Lung	.	.	.	.	.	.	.	5424
28	M	N	1994	22	Yes	Yes	Sarcoid	Yes	Yes	No	No	Lymph	Yes	Yes	No	No	No	No	No	N.A.
29	M	N	1997	44	Yes	No	Sarcoid	Yes	Yes	No	No	Nasal si	Yes	Yes	No	No	No	No	No	N.A.
30	M	.	.	.	Yes	Yes	No. hist.	.	No	.	No	Lung	Yes	No	Yes	No	No	No	No	N.A.

Appendix Table 2. Summary of light microscopic features, AFIP, 2002-2003

ID no.	Sex	Race	Adm. year	Age	Consist. with sarcoidosis? AFIP	SUNY	Diagnosis	Aircraft carr.his. C*	Aircraft carr.his. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	AFIP report: Granulomas?	Necrosis?	Endogenous part's?	Schaumann bodies?	Any particles?	Silica-like particles?	Polarizing part's.?	AFIP no.
31	M	N	1996	37	No	No	Sarcoid	Yes	Yes	Yes	Yes	Lung	No	No	No	No	No	No	No	N.A.
32	M	N	1994	37	No	No	Sarcoid	Yes	Yes	No	No	Bron.‡	No	No	No	No	No	No	No	N.A.

*Abbreviations: C, Career aircraft carrier assignment history. This column show record of assignment to aircraft carrier strictly according to Navy career history file (CHAMPS). If there was no record of assignment, a period (.) is shown; N.A., not available.

†Abbreviation: O, Overall aircraft carrier assignment history. If there was no record of carrier assignment in the Navy career history , "No" is shown, regardless of whether a career history was available on this individual (used in selected analyses).

‡Trans-bronchial biopsy was performed but tissue did not include sufficient lung parenchymal tissue for pathological reading as lung tissue.

§Report begins "Moderate small black particles, probably carbon," then mentions "needle-like particles, probably silica."

¶Report ends with "are birefringent."

Appendix Table 3. Summary of light microscopic features, SUNY, 2002-2003

ID no.	Diagnosis	Aircraft carr. hist. C*	Aircraft carr. hist. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	SUNY report: Any particles?	Particles in gran's.?	Endogenous part's.	Opaque particles?	Birefringent part's.?	TiO_2?	SiO_2?	Talc?	SUNY no.
1	Sarcoid	N	N	N	N	Lung	Yes	Yes	No	Yes	Yes	Yes	No	No	JA02-175
2	Sarcoid	N	N	Y	Y	Lymph	No	No	No	No	No	No	No	No	JA02-298
3	Sarcoid	.	N	Y	Y	Lung	Yes	Yes	No	No	Yes	No	No	No	JA03-130
4	Sarcoid	N	N	Y	Y	Lung	No	No	No	No	No	No	No	No	JA02-301
5	Sarcoid	Y	Y	N	N	Lymph	Yes	Yes	No	No	No	No	Yes	No	JA02-299
6	Pulm. eos.	.	N	N	N	Lung	.	.	.	.	.	.	.	.	.‡
7	Pneum.	.	N	N	N	Lymph	No	No	No	No	No	No	No	No	JA03-133
8	Sarcoid.	N	N	N	N	Lymph	No	No	No	No	No	No	No	No	JA02-297
9	No hosp.	.	N	N	N	Lung	Yes	Yes	No	No	No	Yes	Yes	No	JA03-131
10	URI	.	N	N	N	Lymph	Yes	Yes	No	No	No	Yes	Yes	No	JA03-134
11	Sarcoid.	N	N	Y	Y	Lung	Yes	No	No	Yes	Yes	No	No	No	JA02-303
12	Sarcoid.	N	N	Y	Y	Lung	Yes	Yes	Yes	No	No	No	No	No	JA02-177
13	Sarcoid.	Y	Y	Y	Y	Lung	Yes	Yes	No	Yes	Yes	No	No	No	JA02-300
14	No. hist.	.	N	.	N	Lung	.	.	.	.	.	.	.	.	.‡

Appendix Table 3. Summary of light microscopic features, SUNY, 2002-2003

ID no.	Diag-nosis	Aircraft carr. hist. C*	Aircraft carr. hist. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	SUNY report: Any parti-cles?	Parti-cles in gran's.?	Endo-genous part's.	Opaque par-ticles?	Bire-fringent part's.?	TiO_2?	SiO_2?	Talc?	SUNY no.
15	Sarcoid.	Y	Y	Y	Y	Lymph	No	No	No	No	No	No	No	No	JA02-296
16	No. hist.	.	N	.	N	Lung	Yes	No	No	Yes	Yes	No	No	No	JA02-211
17	No. hist.	.	N	.	N	Bron.§	No	No	No	No	No	No	No	No	JA02-212
18	No. hist.	.	N	.	N	Lung	Yes	No	No	Yes	No	No	No	No	JA02-213
19	No. hist.	.	N	.	N	Lymph	No	No	No	No	No	No	No	No	JA02-214
20	No. hist.	.	N	.	N	Lung	No	No	No	No	No	No	No	No	JA02-215
21	Sarcoid.	N	N	N	N	Lung	Yes	No	No	Yes	No	No	No	No	JA02-302
22	Sarcoid.	N	Y	N	N	Lung	Yes	No	No	No	Yes	Yes	No	No	JA02-304
23	Sarcoid.	.	N	N	N	Lymph	.	.	.	.	.	.	.	.	.‡
24	No hosp.	.	N	Y	Y	Bron.§	No	No	Yes	No	No	No	No	No	JA03-142
25	No hosp.	.	N	N	N	Lymph	No	No	No	No	No	No	No	No	JA03-144
26	No hosp.	.	Y	Y	Y	Lung	Yes	Yes	No	No	No	Yes	Yes	No	JA03-143
27	Sarcoid.	Y	Y	Y	Y	Lung	Yes	No	No	No	No	Yes	Yes	No	JA03-132
28	Sarcoid.	Y	Y	N	N	Lymph	No	No	No	No	No	No	No	No	JA03-138

Appendix Table 3. Summary of light microscopic features, SUNY, 2002-2003

ID no.	Diag-nosis	Aircraft carr. hist. C*	Aircraft carr. hist. O†	Oth. ship history C*	Oth. ship history O†	Type of tissue	SUNY report: Any parti-cles?	Parti-cles in gran's.?	Endo-genous part's.	Opaque par-ticles?	Bire-fringent part's.?	TiO_2?	SiO_2?	Talc?	SUNY no.
29	Sarcoid.	Y	Y	N	N	Sinus	No	No	No	No	No	No	No	No	JA03-140-9460
30	No hist.	.	N	.	N	Lung	No	No	No	No	No	No	No	No	JA03-137
31	Sarcoid.	Y	Y	Y	Y	Lung	Yes	No	No	Yes	No	No	No	No	JA03-136
32	Sarcoid.	Y	Y	N	N	Bron.§	No	No	No	No	No	No	No	No	JA03-140-8109

*Abbreviation: C, Career aircraft carrier assignment history. This column show record of assignment to aircraft carrier strictly according to Navy career history file (CHAMPS). If there was no record of assignment, a period (.) is shown.

†Abbreviation: O, Overall aircraft carrier assignment history. If there was no record of carrier assignment in the Navy career history , "No" is shown here, regardless of whether a career history was available on this individual (used in selected analyses).

‡No report submitted.

§Trans-bronchial biopsy was performed but tissue did not include sufficient lung parenchymal tissue for pathological as lung tissue.

(XL19 Revised 3 Feb 2004 4:10 PM)

Appendix Table 4. Occupations of individuals who served on active duty in the Navy and whose pathological material was available for analysis, 2002-3003

			Occupations held								Occupation at time of diagnosis**	
ID no.	Diagnosis	Hosp. admit year	Occ. No. 1	Start year	Occ No. 2	Start year	Occ. No. 3	Start year	Occ. No. 4	Start year	Occ. at diag.	Start year
1	Sarcoidosis	1971	SR 3600	1964	OS 0300	1966	.	.	.	.	OS 0300	1966
2	Sarcoidosis	1978	SR 3600	1974	RM 1500	1975	.	.	.	.	RM 1500	1975
3	Sarcoidosis	1978	SR 3600	1961	SH 2490	1968	.	.	.	.	SH 2490	1968
4	Sarcoidosis	1975	SH 2490	1959	.	.	.	.	.	.	SH 2490	.
5	Sarcoidosis	1980	SR 3600	1974	DS 1010	1975	.	.	.	.	DS 1010	1975
6	518.30†	1982	SR 3600	1980	HM 8000	1980	.	.	.	.	HM 8000	1980
7	486.0‡	1971	SR 3600	1971	.	.	.	.	.	.	SR 3600	.
8	Sarcoidosis	1990	SR 3600	1985	YN 1700	1986	.	.	.	.	YN 1700	1986
9	NOHOSP‖	.	SR 3600	1968	.	.	.	.	.	.	FR 5000	1970
10	465§	1970	SR 3600	1970	FR 5000	1970	.	.	.	.	SK 2000	1974
11	Sarcoidosis	1991	SR 3600	1972	SK 2000	1974	.	.	.	.	FR 5000	1989
12	Sarcoidosis	1992	CN 5000	1989	.	.	.	.	.	.	FR 5000	1989
13	Sarcoidosis	1984	SR 3600	1973	EM 4100	1973	.	.	.	.	.	.
14	NONAR¶	.	.	.	.	.	.	.	.	.	.	.
15	Sarcoidosis	1996	AR 7800	1986	FN 5000	1986	MM 3700	1988	MS 2200	1991	MS 2200	1991
16	NONAR	.	.	.	.	.	.	.	.	.	.	.
17	NONAR	.	.	.	.	.	.	.	.	.	.	.
18	NONAR	.	.	.	.	.	.	.	.	.	.	.
19	NONAR	.	.	.	.	.	.	.	.	.	.	.
20	NONAR	.	.	.	.	.	.	.	.	.	.	.
21	Sarcoidosis	1970	SR 3600	1965	SK 2000	1970	.	.	.	.	SK 2000	1970
22	Sarcoidosis	1980	SR 3600	1976	YN 1700	1978	.	.	.	.	YN 1700	1978

Appendix Table 4. Occupations of individuals who served on active duty in the Navy and whose pathological material was available for analysis, 2002-3003

			Occupations held								Occupation at time of diagnosis**	
ID no.	Diagnosis	Hosp. admit year	Occ. No. 1	Start year	Occ No. 2	Start year	Occ. No. 3	Start year	Occ. No. 4	Start year	Occ. at diag.	Start year
23	Sarcoidosis	1983	SR 3600	1974	BM 0100	1979	HM 8000	1980	.	.	HM 8000	1980
24	NOHOSP	.	SR 3600	1986	BM 0100	1985	.	.	.	.	BM 0100	1985
25	NOHOSP	.	SR 3600	1968	FR 5000	1969	EN 3800	1969	.	.	EN 3800	1969
26	NOHOSP	.	SR 3600	1979	MS 2200	.	.	.	.	.	MS 2200	1981
27	Sarcoidosis	1995	SR 3600	1976	ABH 6706	1977	.	.	.	.	ABH 6706	1977
28	Sarcoidosis	1994	AR 7800	1992	AO 6500	1993	.	.	.	.	AO 6500	1993
29	Sarcoidosis	1997	SR 3600	1973	DN 8300	1973	DT 8700	1995	.	.	DT 8700	1995
30	NONAR	.	.	.	.	.	.	.	.	.	.	.
31	Sarcoidosis	1997	SR 3600	1977	AN 7800	1977	AMH 6902	1980	AC 6600	1981	JO 2600	1990
32	Sarcoidosis	1994	AR 7800	1976	AO 6500	1977	.	.	.	.	.	.

*Sarcoidosis is ICD-9-CM Code 135. Table shows first four occupations and duty stations.

†ICD-9-CM Code 518.3 is pulmonary eosinophilia.

‡ICD-9-CM code 486.0 is pneumonia, unspecified.

‖NOHOSP denotes an individual who was on active-duty enlisted service in the Navy, but no record could be found of hospitalization in a Navy hospital.

§ICD-9-CM Code 465 denotes acute upper respiratory infection.

¶NONAR denotes an individual for whom no record of active-duty enlisted service in the Navy could be found.

** Occupation at time of diagnosis for sarcoidosis or other lung disease cases, otherwise last occupation.

Appendix Table 5. Duty stations of individuals who served on active duty in the Navy and whose pathological material was available for analysis, 2002-3003*

ID no.	Diagnosis	Hosp. admit year	Duty stations: Duty No. 1	Start year	Duty No. 2	Start year	Duty No. 3	Start year	Duty No. 4	Start year	Other ship	Start year	Acft. car.	Start year	Air sqdrn.	Start year	Duty sta. at time of first hosp.: UIC† PAMI	Sta. type	Start year
1	Sarcoidosis	1971	C6502	1964	P5271	1965	.	.	.	.	No	.	No	.	No	.	P5271		1965
2	Sarcoidosis	1978	30646	1974	30627	1974	33252	1975	52685	1976	DDG	1976	No	.	No	.	52685		1975
3	Sarcoidosis	1978	P2169	1961	P4074	1969	C8121	1971	P2015	1977	DDG	1973	No	.	No	.	39234		1978
4	Sarcoidosis	1975	P4057	1959	C8124	1967	P9768	1967	P9737	1969	DE	1973	No	.	No	.	54059	DE	1973
5	Sarcoidosis	1980	31155	1974	30627	1974	30945	1974	03365	1976	No	.	CVN	1976	35667	1977	30681		1979
6	518.30	1982	31155	1980	30639	1980	68056	1980	30639	1980	No	.	No	.	No	.	66818		1981
7	486.0	1971	C4037	1971	.	.	.	.	.	.	No	.	No	.	No	.	C4037		1971
8	Sarcoidosis	1990	31155	1985	30128	1986	20834	1986	55600	1989	No	.	No	.	55600	1989			
9	NOHOSP‡	.	C7292	1968	P9430	1968	P1443	1970	P1028	1971	No	.	No	.	No	.	.		.
10	465	1970	C6502	1970	.	.	.	.	.	.	No		No	.	No	.	C6502		1970
11	Sarcoidosis	1991	P0468	1972	4316	1972	52704	1972	60050	1976	CG‡	1972	No	.	No	.	52903		1987
12	Sarcoidosis	1992	31155	1989	42081	1990	21625	1990	.	.	CG	1990	No	.	No	.	21625		1990
13	Sarcoidosis	1984	P0468	1973	30626	1973	3366	1974	31744	1974	CG‖	1973	CVA	1974	No	.	42524		1982
14	NONAR§	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.

Appendix Table 5. Duty stations of individuals who served on active duty in the Navy and whose pathological material was available for analysis, 2002-3003*

ID no.	Diagnosis	Hosp. admit year	Duty stations: Duty No. 1	Start year	Duty No. 2	Start year	Duty No. 3	Start year	Duty No. 4	Start year	Other ship	Start year	Acft. car.	Start year	Air sqdrn.	Start year	Duty sta. at time of first hosp.: UIC† PAMI	Sta. type	Start year
15	Sarcoidosis	1996	31155	1986	30565	1986	21247	1986	32002	1989	DDG	1989	CVN	1993	No	.	21449	CG	1995
16	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
17	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
18	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
19	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
20	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
21	Sarcoidosis	1970	C6502	1965	P2108	1966	C8848	1970	.	.	No	No	No	.	.	.	.		.
22	Sarcoidosis	1980	31155	1976	3360	1976	.	.	.	.	No	.	CV	1976	No	.	3360	CV	1976
23	Sarcoidosis	1983	30644	1974	60681	1974	39233	1975	31832	1975	No	.	No	.	No	.	66096		1982
24	NOHOSP	.	30646	1986	30639	1986	32005	1986	07202	1986	LPH	1986	No	.	No	.	.		.
25	NOHOSP	.	C7292	1968	P4380	1968	P6311	1970	P6311	1970	No	.	No	.	No	.	.		.
26	NOHOSP	.	30646	1979	30627	1980	33019	1980	03359	1980	LPH	1986	CV	1980	No	.	.		.
27	Sarcoidosis	1995	30643	1976	30460	1977	389	1977	32002	1979	LHA	1979	CVN	1981	No	.	30459		1993
28	Sarcoidosis	1994	31155	1992	21247	1992	.	.	.	.	No	.	CVN	1992	No	.	21247		1994

Appendix Table 5. Duty stations of individuals who served on active duty in the Navy and whose pathological material was available for analysis, 2002-3003*

ID no.	Diagnosis	Hosp. admit year	Duty stations: Duty No. 1	Start year	Duty No. 2	Start year	Duty No. 3	Start year	Duty No. 4	Start year	Other ship	Start year	Acft. car.	Start year	Air sqdrn.	Start year	Duty sta. at time of first hosp.: UIC† PAMI	Sta. type	Start year
29	Sarcoidosis	1997	31155	1973	0609A	1973	60285	1974	68094	1974	No	.	CV	1993	No	.	62753		1997
30	NONAR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31	Sarcoidosis	1996	30646	1977	30459	1977	65551	1977	09196	1977	LHD	1995	CV	1987	09196	1977	21700	LHI	1995
32	Sarcoidosis	1994	30646	1976	60530	1977	30459	1977	09062	1977	No	.	CV	1987	09940	1979	.	.	.

*Table shows first four occupations and duty stations

†Abbreviation: UIC, unit identification code; PAMI, Pacific-Atlantic identification code

Appendix Table 6. Results of SEM-EDXA analyses of pathological materials from postmortem examinations, SUNY, 2003

(Miscellaneous non-military occupations)

SUNY No.	Total particles*	Silica	Alum. silicate	Total metals	Talc	Fe	Ti	Al	Other metal	Age	Sex	Smok. hist.	Pack-years	Residence	Lung pathology	Occupational history
1	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	Ba Sn	2 mos	F	No	0	Syracuse NY	Only term.changes	Infant
2	2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0		51	F	No	0	Baldwinsville	Only term.changes	Bowling alley worker
3	3.0	0.8	0.8	1.5	0.0	0.0	0.0	0.0		58	M	No	0	Lycoming NY	Only term.changes	Security superv., NY Power
4	4.6	0.0	3.4	0.0	0.0	0.0	0.0	0.0		71	M	No	0	Gouverneur	Only term.changes	Dairy farmer
5	6.9	2.3	1.1	3.4	0.0	3.0	2.0	1.0		74	M	Yes	Unk.	Syracuse NY	Only term.changes	Expediter
6	6.9	0.0	2.3	2.3	0.0	2.0	0.0	0.0		78	M	No	0	Watertown	Only term.changes	Hotel manager
7	9.1	1.1	0.0	5.7	2.3	1.0	0.0	0.0	Ba Cr Sn	66	F	No	0	Hermon NY	Only term.changes	Language teacher
8	9.1	3.4	1.1	3.4	0.0	1.0	0.0	0.0	Zn Sn	82	M	Unk.	Unk.	Syracuse NY	Only term.changes	Nursing home resident
9	9.1	2.3	0.0	2.3	2.3	1.0	0.0	1.0	Ni	41	M	Yes	20	Syracuse NY	Only term.changes	University Professor
10	10.3	1.1	6.9	2.3	0.0	2.0	0.0	1.0	Cr	23	M	Unk.	Unk.	New Hartford	Only term.changes	Computer programmer
11	10.3	0.0	3.7	6.6	0.0	1.0	1.0	1.0	Bi	53	F	Yes	35	Watertown	Only term.changes	Housewife
12	10.3	1.1	2.3	6.9	0.0	3.0	1.0	3.0	Sn	23	M	Unk.	Unk.	Syracuse NY	Only term.changes	Attended technical school
13	10.9	3.3	1.1	5.4	0.0	0.0	0.0	0.0		47	M	Unk.	Unk.	Norway	Only term.changes	Ni refinery, tankhouse 19 yr
14	11.0	1.0	1.0	9.0	0.0	0.0	0.0	0.0		76	M	Unk.	Unk.	Norway	Only term.changes	Ni refinery, tankhouse 46 yr
15	11.4	2.3	3.4	5.7	0.0	1.0	2.0	0.0	Sn	57	M	Yes	90	Port Byron NY	Only term.changes	Motel worker
16	12.6	2.3	0.0	9.1	1.1	0.0	0.0	0.0		57	F	No	0	North Country	Only term.changes	Secretary
17	13.7	1.1	11.4	1.1	0.0	0.0	1.0	0.0		44	M	Yes	Unk.	Gouverneur	Only term.changes	Dept of Transportation

Appendix Table 6 Results of SEM-EDXA analyses of pathological materials from postmortem examinations, SUNY, 2003

(Miscellaneous non-military occupations)

SUNY No.	Total particles*	Silica	Alum. silicate	Total metals	Talc	Fe	Ti	Al	Other metal	Age	Sex	Smok. hist.	Pack-years	Residence	Lung pathology	Occupational history
18	14.9	1.1	10.3	3.4	0.0	2.0	0.0	0.0	W	86	M	Yes	Unk.	Syracuse NY	Only term.changes	Retired farmer
19	16.0	3.4	2.3	10.3	0.0	4.0	3.0	1.0	Cr Sn C	19	M	Unk.	Unk.	Watertown	Only term.changes	Construction eqpt. (fatality)

*All particle concentrations are expressed as millions of particles per cubic centimeter of lung tissue.

Source: J. L. Abraham, M.D., October 2003

Appendix Table 7. Results of SEM-EDXA analyses of pathological materials from postmortem examinations, SUNY, 2003

(Miscellaneous non-military occupations)

SUNY No.	Total particles*	Silica	Alum. silicate	Total metals	Talc	Fe	Ti	Al	Other metal	Age	Sex	Smok. hist.	Pack-years	Residence	Lung pathology	Occupational history
1	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	Ba Sn	2 mos	F	No	0	Syracuse NY	Only term.changes	Infant
2	2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0		51	F	No	0	Baldwinsville	Only term.changes	Bowling alley worker
3	3.0	0.8	0.8	1.5	0.0	0.0	0.0	0.0		58	M	No	0	Lycoming NY	Only term.changes	Security superv., NY Power
4	4.6	0.0	3.4	0.0	0.0	0.0	0.0	0.0		71	M	No	0	Gouverneur	Only term.changes	Dairy farmer
5	6.9	2.3	1.1	3.4	0.0	3.0	2.0	1.0		74	M	Yes	Unk.	Syracuse NY	Only term.changes	Expediter
6	6.9	0.0	2.3	2.3	0.0	2.0	0.0	0.0		78	M	No	0	Watertown	Only term.changes	Hotel manager
7	9.1	1.1	0.0	5.7	2.3	1.0	0.0	0.0	Ba Cr Sn	66	F	No	0	Hermon NY	Only term.changes	Language teacher
8	9.1	3.4	1.1	3.4	0.0	1.0	0.0	0.0	Zn Sn	82	M	Unk.	Unk.	Syracuse NY	Only term.changes	Nursing home resident
9	9.1	2.3	0.0	2.3	2.3	1.0	0.0	1.0	Ni	41	M	Yes	20	Syracuse NY	Only term.changes	University Professor
10	10.3	1.1	6.9	2.3	0.0	2.0	0.0	1.0	Cr	23	M	Unk.	Unk.	New Hartford	Only term.changes	Computer programmer
11	10.3	0.0	3.7	6.6	0.0	1.0	1.0	1.0	Bi	53	F	Yes	35	Watertown	Only term.changes	Housewife
12	10.3	1.1	2.3	6.9	0.0	3.0	1.0	3.0	Sn	23	M	Unk.	Unk.	Syracuse NY	Only term.changes	Attended technical school
13	10.9	3.3	1.1	5.4	0.0	0.0	0.0	0.0		47	M	Unk.	Unk.	Norway	Only term.changes	Ni refinery, tankhouse 19 yr
14	11.0	1.0	1.0	9.0	0.0	0.0	0.0	0.0		76	M	Unk.	Unk.	Norway	Only term.changes	Ni refinery, tankhouse 46 yr
15	11.4	2.3	3.4	5.7	0.0	1.0	2.0	0.0	Sn	57	M	Yes	90	Port Byron NY	Only term.changes	Motel worker
16	12.6	2.3	0.0	9.1	1.1	0.0	0.0	0.0		57	F	No	0	North Country	Only term.changes	Secretary
17	13.7	1.1	11.4	1.1	0.0	0.0	1.0	0.0		44	M	Yes	Unk.	Gouverneur	Only term.changes	Dept of Transportation

Appendix Table 7. Results of SEM-EDXA analyses of pathological materials from postmortem examinations, SUNY, 2003

(Miscellaneous non-military occupations)

SUNY No.	Total particles*	Silica	Alum. silicate	Total metals	Talc	Fe	Ti	Al	Other metal	Age	Sex	Smok. hist.	Pack-years	Residence	Lung pathology	Occupational history
18	14.9	1.1	10.3	3.4	0.0	2.0	0.0	0.0	W	86	M	Yes	Unk.	Syracuse NY	Only term.changes	Retired farmer
19	16.0	3.4	2.3	10.3	0.0	4.0	3.0	1.0	Cr Sn C	19	M	Unk.	Unk.	Watertown	Only term.changes	Construction eqpt. (fatality)

*All particle concentrations are expressed as millions of particles per cubic centimeter of lung tissue.

Source: J. L. Abraham, M.D., October 2003

(Table A7, XL 23, 15 Jan 2004 14:42 v. 1.1)

Appendix Table 8. Results of light microscopy by AFIP, 2002-2003

ID No.	Diag-nosis	Occu-pation	Description	AFIP ID	Tissue	Any particles	Any part. code	Silicate-like code
1	Sarcoidosis	OS 0300	Operations Spec.	1249	Lung	Few small black particles	1	0
2	Sarcoidosis	RM 1500	Radioman	7849	Lymphatic	No	0	0
3	Sarcoidosis	SH 2490	Ship's Serviceman	0288	Tbb - Lung	Few small black particles	1	0
4	Sarcoidosis	SH 2490	Ship's Serviceman	6782	Lung	No	0	0
5	Sarcoidosis	DS 1010	Data Systems Tech.	9975	Lymphatic	Small black particles - Few	1	0
6	Pulm. Eosin.	HM 8000	Hospitalman	9272	Tbb - Lung	No	0	0
7	Pneumonia	SR 3600	Seaman Recruit	5231	Lymphatic	No	0	0
8	Sarcoidosis	YN 1700	Yeoman	4870	Lymphatic	No	0	0
9	No hosp.	SR 3600	Seaman Recruit	8634	Tbb - Lung	Rare black particles	1	0
10	Acute URI	SR 3600	Seaman Recruit	1666	Lymphatic	Few black small particles	1	0
11	Sarcoidosis	SK 2000	Storekeeper	8553	Lung	Yes, lots of sm. black & silica-like parts.	1	1
12	Sarcoidosis	FR 5000	Fireman Recruit	2516	Tbb - Lung	Rare crystalline particles	1	0
13	Sarcoidosis	EM 4100	Electrician's Mate	6959	Lung	Rare sm. blck. parts., prob. C & silica-like	1	1
14	No history	.	.	5643	Lung	No	0	0
15	Sarcoidosis	MS 2200	Mess Management	8424	Lymphatic	No	0	0
16	No history	.	.	8850	Tbb -Lung	Rare sm. black particles, probably carbon	1	0
17	No history	.	.	1280	Tbb -Bronch.	No	0	0
18	No history	.	.	9113	Lung	Yes, mod. sm. black parts., prob. C*	1	1
19	No history	.	.	0746	Lymphatic	No	0	0
20	No history	.	.	0567	Lung	No	0	0
21	Sarcoidosis	SK 2000	Storekeeper	8816	Lung	Few small black particles prob. C†	1	0
22	Sarcoidosis	YN 1700	Yeoman	4427	Tbb - Lung	No	0	0
23	Sarcoidosis	HM 8000	Hospitalman	0075	Lymphatic	.	.	.
24	No hosp.	BM 0100	Boatswain's Mate	9153	Tbb - Lung	No	0	0
25	No hosp.	EN 3800	Engineman	2418	Lymphatic	Few small black particles	1	1

Appendix Table 8. Results of light microscopy by AFIP, 2002-2003

ID No.	Diag-nosis	Occu-pation	Description	AFIP ID	Tissue	Any particles	Any part. code	Silicate-like code
26	No hosp.	MS 2200	Mess Management	5453	Tbb - Lung	Few opaque particles	1	0
27	Sarcoidosis	ABH 6706	Av. Boatsw. Mate‡	5424	Tbb	.	.	.
28	Sarcoidosis	AO 6500	Av. Ordnanceman	8563	Lymphatic	No	0	0
29	Sarcoidosis	DT 8700	Dental Technician	9460	Bone & mucos	No	0	0
30	No history	.	.	0259	Tbb - Lung	No	0	0
31	Sarcoidosis	JO 2600	Journalist	0969	Tbb - Lung	No	0	0
32	Sarcoidosis	AO 6500	Av. Ordnanceman	8109	Tbb - Bronch.	No	0	0

Appendix Table 8--*Continued.* Results of light microscopy by AFIP, 2002-2003

ID No.	Diag-nosis	Endogenous particles	Endo. particles code	Schau-mann code	Birefringent particles
1	Sarcoidosis	Yes	1	0	Scattered crystals
2	Sarcoidosis	No	0	0	No
3	Sarcoidosis	No	0	0	No
4	Sarcoidosis	No	0	0	No
5	Sarcoidosis	No	0	0	No
6	Pulm. Eosin.	Yes, small	1	0	No
7	Pneumonia	No	0	0	No
8	Sarcoidosis	No	0	0	Rare small particles
9	No hosp.	Rare, small	1	0	No
10	Acute URI	No	0	0	Rare small particles
11	Sarcoidosis	No	0	0	Yes, lots of needle-like particles
12	Sarcoidosis	No	0	0	Rare small crystalline particles
13	Sarcoidosis	Yes; Schaumann bodies	1	1	Rare needle silica like
14	No history	No	0	0	No
15	Sarcoidosis	No	0	0	No
16	No history	No	0	0	No
17	No history	No	0	0	No
18	No history	No	0	0	Yes, silica-like particles
19	No history	No	0	0	No
20	No history	No	0	0	No
21	Sarcoidosis	1+; also Schaumann body	1	1	Rare
22	Sarcoidosis	No	0	0	No
23	Sarcoidosis	.	.	.	.
24	No hosp.	Yes - lots	1	0	Lg. crystalline parts. - look endogenous are birefringent
25	No hosp.	No	0	0	Few needle like silica particle

Appendix Table 8--*Continued.* Results of light microscopy by AFIP, 2002-2003

ID No.	Diag-nosis	Endogenous particles	Endo. particles code	Schau-mann code	Birefringent particles
26	No hosp.	Yes	1	0	Scatt'd. birefringent parts.
27	Sarcoidosis	.	.	.	.
28	Sarcoidosis	No	0	0	No
29	Sarcoidosis	No	0	0	No
30	No history	Rare	1	0	No
31	Sarcoidosis	No	0	0	No
32	Sarcoidosis	No	0	0	No

(Appx. Table 8, 19 Jan 2004 13:05, v. 1.0)

Appendix Table 9. Results of light microscopy by SUNY, 2002-2003

ID No.	Diag-nosis	Occu-pation	Description	AFIP ID	Tissue	Any particles	Any part. code	Particles in granulomas	Parts. in grans. code	Silica	Silica code
1	Sarcoidosis	OS 0300	Operations Spec.	1249	Lung	Y	1	Yes	1	No	0
2	Sarcoidosis	RM 1500	Radioman	7849	Lymphatic	N	0	No	0	No	0
3	Sarcoidosis	SH 2490	Ship's Serviceman	0288	Tbb - Lung	Y	1	Yes	1	No	0
4	Sarcoidosis	SH 2490	Ship's Serviceman	6782	Lung	N	0	No	0	No	0
5	Sarcoidosis	DS 1010	Data Systems Tech.	9975	Lymphatic	Y	1	Yes	1	Yes	1
6	Pulm. Eosin.	HM 8000	Hospitalman	9272	Tbb - Lung	.	.	.	.	.	.
7	Pneumonia	SR 3600	Seaman Recruit	5231	Lymphatic	N	0	No	0	No	0
8	Sarcoidosis	YN 1700	Yeoman	4870	Lymphatic	N	0	No	0	No	0
9	No hosp.	SR 3600	Seaman Recruit	8634	Tbb - Lung	Y	1	Yes	1	Yes	1
10	Acute URI	SR 3600	Seaman Recruit	1666	Lymphatic	Y	1	Yes	1	Yes	1
11	Sarcoidosis	SK 2000	Storekeeper	8553	Lung	Y	1	No	0	No	0
12	Sarcoidosis	FR 5000	Fireman Recruit	2516	Tbb - Lung	Y	1	Yes	1	No	0
13	Sarcoidosis	EM 4100	Electrician's Mate	6959	Lung	Y	1	Yes	1	No	0
14	No history	.	.	5643	Lung	.	.	.	.	.	.
15	Sarcoidosis	MS 2200	Mess Management	8424	Lymphatic	N	0	No	0	No	0
16	No history	.	.	8850	Tbb -Lung	Y	1	No	0	No	0
17	No history	.	.	1280	Tbb -Bronch.	N	0	No	0	No	0
18	No history	.	.	9113	Lung	Y	1	No	0	No	0
19	No history	.	.	0746	Lymphatic	N	0	No	0	No	0
20	No history	.	.	0567	Lung	N	0	No	0	No	0
21	Sarcoidosis	SK 2000	Storekeeper	8816	Lung	Y	1	No	0	No	0
22	Sarcoidosis	YN 1700	Yeoman	4427	Tbb - Lung	Y	1	No	0	No	0
23	Sarcoidosis	HM 8000	Hospitalman	0075	Lymphatic	.	.	.	.	.	.
24	No hosp.	BM 0100	Boatswain's Mate	9153	Tbb - Lung	N	0	No	0	No	0
25	No hosp.	EN 3800	Engineman	2418	Lymphatic	N	0	No	0	No	0

Appendix Table 9. Results of light microscopy by SUNY, 2002-2003

ID No.	Diag-nosis	Occu-pation	Description	AFIP ID	Tissue	Any particles	Any part. code	Particles in granulomas	Parts. in grans. code	Silica	Silica code
26	No hosp.	MS 2200	Mess Management	5453	Tbb - Lung	Y	1	Yes	1	Yes	1
27	Sarcoidosis	ABH 6706	Av. Boatsw. Mate‡	5424	Tbb	Y	1	No	0	Yes	1
28	Sarcoidosis	AO 6500	Av. Ordnanceman	8563	Lymphatic	N	0	No	0	No	0
29	Sarcoidosis	DT 8700	Dental Technician	9460	Bone, mucosa	N	0	No	0	No	0
30	No history	.	.	0259	Tbb - Lung	N	0	No	0	No	0
31	Sarcoidosis	JO 2600	Journalist	0969	Tbb - Lung	Y	1	No	0	No	0
32	Sarcoidosis	AO 6500	Av. Ordnanceman	8109	Tbb - Bronch.	N	0	No	0	No	0

Appendix Table 9--*Continued.* Results of light microscopy by SUNY, 2002-2003

ID No.	Endo-genous particles	Endo-genous code	Opaque particles	Opaque code	Bire-fringent particles	Bire-fringent code	TiO_2	TiO_2 code	Talc	Talc code
1	No	0	Yes	1	Yes	1	Yes	1	No	0
2	No	0	No	0	No	0	No	0	No	0
3	.	.	.	.	Yes	1	No	0	No	0
4	No	0	No	0	No	0	No	0	No	0
5	.	.	.	.	.	.	No	0	No	0
6	.	.	.	.	.	.	.	.	.	.
7	.	.	.	.	.	.	No	0	.	.
8	.	.	.	.	.	.	No	0	.	.
9	.	.	.	.	.	.	Yes	1	.	.
10	.	.	.	.	.	.	Yes	1	.	.
11	No	0	Yes	1	Yes	1	No	0	No	0
12	Yes	1	No	0	No	0	No	0	No	0
13	No	0	Yes	1	Yes	1	No	0	No	0
14	.	.	.	.	.	.	.	.	.	.
15	No	0	No	0	.	.	No	0	.	.
16	No	0	Yes	1	Yes	1	No	0	No	0
17	No	0	.	.	.	.	No	0	.	.
18	No	0	Yes	1	No	0	No	0	No	0
19	.	.	.	.	.	.	No	0	.	.
20	.	.	.	.	.	.	No	0	.	.
21	No	0	Yes	1	.	.	No	0	.	.
22	No	0	No	0	Yes	1	Yes	1	No	0
23	.	.	.	.	.	.	.	.	.	.
24	Yes	1	No	0	.	.	No	0	.	.
25	.	.	No	0	.	.	No	0	.	.

Appendix Table 9--*Continued.* Results of light microscopy by SUNY, 2002-2003

ID No.	Endo-genous particles	Endo-genous code	Opaque particles	Opaque code	Bire-fringent particles	Bire-fringent code	TiO_2	TiO_2 code	Talc	Talc code
26	.	.	.	.	.	.	Yes	1	.	.
27	.	.	.	.	.	.	Yes	1	.	.
28	.	.	.	.	.	.	No	0	.	.
29	.	.	.	.	.	.	No	0	.	.
30	.	.	.	.	.	.	No	0	.	.
31	.	.	Yes	1	.	.	No	0	.	.
32	.	.	.	.	.	.	No	0	.	.

12.0 Attachments

A. Epidemiological Study 1
B. Epidemiological Study 2
C. Progress Report 1, 8 October 2001
D. Progress Report 2, 8 October 2002
E. Management Plan
F. American Institute for Biological Sciences Review
G. Meeting Minutes, San Diego CA, February 25, 2003

DEPARTMENT OF THE NAVY
NAVAL HEALTH RESEARCH CENTER
POST OFFICE BOX 85122
SAN DIEGO, CA 92186-5122

IN REPLY REFER TO:
5721
Ser 00/57
30 Mar 04

From: Commanding Officer, Naval Health Research Center, San Diego
To: Chief, Bureau of Medicine and Surgery (MED-00P)
Via: Chief, Bureau of Medicine and Surgery (M2B), 2300 E St NW, Washington, DC 20372-5300

Subj: REQUEST FOR PUBLICATION CLEARANCE, PUBLIC AFFAIRS PROGRAM

Ref: (a) BUMEDINST 5721.3
(b) BUMED ltr 5721, Ser 26B/00U0484 of 22 Sep 01
(c) BUMED ltr 5721 Ser 00P03/270 of 15 Dec 03

Encl: (1) BUMED 5721.3 Clearance for Publication Form with NHRC Report 04-06 "Navy Lung Disease Assessment Program, Final Report, 18 Feb 04" (F Garland/Gorham/Kaiser/et al.) with attachments:
A. Epidemiological Study 1: NHRC Report 02-21, "Trends and Occupational Associations in Incidence of Lung Disease in Navy Personnel: A 27-Year Historical Prospective Study, 1975-2001" (Gorham ED, et al.)
B. Epidemiological Study 2: NHRC Report 02-34, "Shipboard Duty - Station Assignments and Incidence of Sarcoidosis in Navy Personnel: A Nested Case-Control Study, 1965-2001" (Gorham ED, et al.)
C. Progress Report No. 1 (8 Oct 01)
D. Progress Report No. 2 (8 Oct 02)
E. Management Plan (7 Oct 02)
F. American Institute for Biological Sciences Review (Jul 02)
G. Meeting Minutes for 25 Feb 03 (31 Mar 03)

1. **FORWARDED FOR REVIEW AND APPROVAL** per references (a) and (b). The report and attachments in enclosure (1) have been reviewed by this command. Upon approval, the report will eventually be published. Attachments (A) and (B), supporting documents to this report, have previous BUMED approval, reference (c). Please review Attachments C through G of enclosure (1). The DoD Assurance number is 2002.0006 (formerly 32257).

2. The report does contain sensitive information.

JAMES T. LUZ

CLASSIFICATION
UNCLASSIFIED

COMMANDING OFFICER
NAVAL HEALTH RESEARCH CENTER
PO BOX 85122
SAN DIEGO CA 92186-5122

(Sender: Check appropriate Box)

☒ This transmittal is unclassified
Upon removal of enclosure(s)

☐ This transmittal is (Insert Classification)

Upon removal of enclosure(s).

IN REPLY REFER TO
Tel: (619) 524-9876
Code: 24
POC: Dr. Ed Gorham

DOCUMENT TRANSMITTAL AND RECEIPT

DATE
3/31/2004 10:39:16 AM

TO: Chief Bureau of Medicine and Surgery (M2)
Attn: Ken Wimmer (202-762-3508/0470)
2300 E Street NW
Washington, DC 20372-5300

MAILING INFORMATION
(Registered/Certified Number)

REFERENCE (Identify source and date of request, contract number, or related work project)

MATERIAL LISTED BELOW IS FORWARDED FOR
☒ INFORMATION AND RETENTION* ☐ REVIEW AND COMMENT ☐ RETURN FROM LOAN ☐ LOAN TO RETURNED BY (*date*) _____

QTY	DESCRIPTION OF ENCLOSURES (Give Title, S-Number & Bar Code Number (if applicable) for Controlled Secret Material)	COPY NO.	SECURITY CLASSIFICATION
1	Manuscript Submittal	1	Unclassified

REMARKS
Please send via Federal Express- Overnight Delivery

Job Order Number: 40000283940010, Cost Center Code: 2200000

NAME, RANK AND TITLE OF APPROVING OFFICIAL
G. W. MCCURTIS, ADMIN SUPVSR

SIGNATURE

RECEIPT OF THE ABOVE LISTED ENCLOSURES(S) ACKNOWLEDGED
Security regulations require an acknowledment of the receipt of Secret material. If this transmittal contained a Secret enclosure(s) please verify that the material indentified in the "DESCRIPTION OF ENCLOSURES" above, was received by signing below and returning this form to the address listed as the "sender", above. Notify the sender immediately of any discrepancies in the material received if different from that listed.

TITLE	SIGNATURE	DATE
		3.31.2004

*NOTE: Upon completion of contact(s) or when material has served its purpose, destroy per instruction in security manual for classified information or industrial security manual for safeguarding classified information

COPY TO

CLASSIFICATION
Unclassified

SSC-SD 5216/21 (REV 6-98)

SCIENTIFIC DIRECTOR	14 JAN 04	6320	NHRC.2002.0006 (previously #32257)

FROM (Senior Author)
F. C. Garland, Ph.D.

Via Command Editor (Initials & Date)
Edited by M Stoia 1/22/04

Co-Authors
E.D. Gorham, K. Kaiser, W.D. Travis, J.A. Centeno, J.L. Abraham, F. Hasibuan.

Title
Navy Lung Disease Assessment Program: Final Report

APPROVAL REQUEST FOR (Check all that apply)

	PRESENTATION / POSTER (Meeting, Place, Date)
	DEFENSE AUTOMATED PRINTING SERVICE (Attach diskette or filename of Abstract & Manuscript)
	JOURNAL (Journal Name) (Attach diskette or filename of Abstract & Manuscript)
X	**OTHER** (Book Chapter, Proceedings, etc., specify) (Attach diskette or filename of Abstract & Manuscript) Final Report. See PC Common:Gorham:NLDAP Final Report: NLDAP_Abstract, NLDAP_Final_Report_v35.doc

SUBJECT INDEX FOR WEBPAGE (Check all that apply)

OPERATIONAL
- ☑ MIOLOGY
- ury
- ccupational Health
- ☐ HIV & Sexually Transmitted Diseases
- ☐ Microbiology
- ☐ Gulf War Veterans
- ☐ Prisoners of War
- X Other Disease Categories
- ☐ Other Operational Epidemiology

HEALTH AND WELLNESS
- ☐ Health Promotion and Disease Prevention
- ☐ Alcohol
- ☐ Smoking
- ☐ Stress Management/Suicide
- ☐ Mental Health/Personality/Mood
- ☐ Nutrition
- ☐ Body Composition
- ☐ Deployment
- ☐ Military Family
- ☐ Domestic Violence
- X Other Health and Wellness

HEALTH CARE OPERATIONS
- ☐ Patient Satisfaction
- X Health Care Utilization
- ☐ Organizational Studies
- ☐ Other Health Care Operations

MEDICAL INFORMATION SYSTEMS
- ☐ Decision Support
- ☐ Casualty Documentation (MEDTAG)
- ☐ Medical Data Acquisition
- ☐ Telemedicine
- ☐ System Design and Evaluation
- X Other Medical Information Systems

MEDICAL OPERATIONS RESEARCH
- ☐ Combat Casualty Forecasting
- ☐ Disease & Non-Battle Injury (DNBI) Projections
- ☐ Medical Evacuation
- ☐ Medical Resource Management
- ☐ Medical Modeling and Simulation
- ☐ Other Medical Operations Research

HUMAN PERFORMANCE AND PHYSICAL READINESS
- ☐ Environmental Physiology
- ☐ Exercise Physiology, Physical Readiness & Training
- ☐ Protective Clothing and Equipment Evaluation
- ☐ Human Performance Modeling
- ☐ Other Human Performance

APPLIED PSYCHOPHYSIOLOGY
- ☐ Sleep and Sleep Deprivation Studies
- ☐ Circadian Rhythms
- ☐ Cognitive Performance
- ☐ Electrophysiology
- ☐ Alertness Monitoring
- ☐ Psychopharmacology
- ☐ Stress
- ☐ Other Applied Psychophysiology

PLATFORMS
- X Surface
- ☐ Submarine
- X Aviation
- ☐ Special Warfare (SEALs)
- ☐ Marine Corps
- ☐ Divers
- ☐ Antarctic
- X Medical Treatment Facilities
- ☐ Other Platforms

ACTION

SCIENTIFIC DIRECTOR (Signature & Date)	☐ TR ☐ TD ☒ Bumed Approval	COMMANDING OFFICER (Signature & Date)
Paula Konsek 3/11/04		16 MAR 04
gned NHRC Report Number 04-06		Date Assigned 3-16-04

INSTRUCTIONS: Submit this approval form in DUPLICATE with one Xerox Copy of manuscript (no original), together with completed SF 298, to Scientific Director, for review, who will then forward to the Commanding Officer for final review and approval. Upon approval, the *original* approval form will be returned to the senior author for filing; the duplicate form, manuscript, and SF 298 are retained in the Office of the Commanding Officer.

Trends and Occupational Associations in Incidence of Lung Disease in Navy Personnel: A 27-Year Historical Prospective Study, 1975-2001

Edward D. Gorham, M.P.H., Ph.D.[1]; Cedric F. Garland, Dr. P.H.[2]; Frank C. Garland, Ph.D.[1]; CAPT Richard Thomas[3]; Kevin Kaiser, M.P.H.[4]; William D. Travis, M.D.[5], Jose A. Centeno, Ph.D. [5]

[1]Naval Health Research Center, San Diego, CA

[2]Department of Family and Preventive Medicine, University of California, San Diego, La Jolla, CA

[3]Navy Environmental Health Center, Norfolk VA

[4]GEO-CENTERS, INC., Clinton, MD 20735

[5]Armed Forces Institute of Pathology, Washington, DC 20306-6000

Corresponding author: Edward D. Gorham, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92186-5122. Telephone (619) 524-9876; fax (619) 524-9888; e-mail: gorham@nhrc.navy.mil

Word count: abstract 340; remaining text 3,0363

Report Number 02-21 was supported by the Navy Bureau of Medicine and Surgery, under work unit 60208. The views expressed in this report are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or U.S. Government. Approved for public release; distribution unlimited. This research has been conducted in compliance with all applicable Federal Regulations governing the protection of human subjects in research.

Acknowledgments

The authors are grateful for the thoughtful contributions and helpful guidance and information provided by the following individuals: Gary Hunninghake, M.D., Chairman, Navy Lung Disease Assessment Program Scientific Advisory Council, Sarcoidosis Research Institute and Professor, Pulmonary Division, University of Iowa College of Medicine; Victor Roggli, M.D., Chairman, Surgical Case Review Committee, Durham VA Medical Center and Professor, Department of Pathology, Duke University School of Medicine; Mr. Jerry Cochran, Pastor, and Director, Jerry Cochran Veterans Outreach Foundation; Magdi Soliman, Ph.D., Professor of Pharmacology and Toxicology Program, Director, Environmental Health and Toxicology Research Program, Florida A&M University; Jerrold L. Abraham, M.D., Director, Pathology Core Laboratory for the New York Occupational Health Clinics Network and Professor of Pathology, State University of New York at Syracuse NY; Elaine B. Panitz, M.D., M.P.H., Clinical Assistant Professor, Department of Medicine, Robert Wood Johnson Medical School, Piscataway, NJ; CAPT Garry Rudolph, Navy Bureau of Medicine and Surgery, Washington, DC; Dr. Florabel Mullick, Principal Deputy Director, Armed Forces Institute of Pathology, Washington, DC; CAPT David Trump, Uniformed Services University of the Health Sciences, Bethesda, MD; and Dr. Han Kang, Veterans Administration, Washington, DC. The authors express thanks to Milan Miller for data from the Career History Archival Medical and Personnel System at the Naval Health Research Center, San Diego, CA, and CAPT Ken Capps from the Department of Clinical Investigations, Walter Reed Army Medical Center, Washington, D.C. for his scientific-chemical review of case materials. We also express our gratitude to Mike Dove and Scott Segar of the Defense Manpower Data Center, Monterey, CA, and Mariam Serra from the Department of Environmental and Toxicologic Pathology, AFIP, for their valuable technical assistance and provision of data and to Ms. Michele Cambou at the Naval Health Research Center for her superlative contributions and skills in data analysis.

Abstract

The Navy Bureau of Medicine and Surgery requested establishment of an occupational lung disease assessment program to examine the extent to which lung diseases, especially sarcoidosis, may have been misdiagnosed among Navy personnel, and to evaluate the relationship between sarcoidosis and other lung disease to occupation and service aboard Navy ships. Formulations of nonskid coatings that have been used on Navy ship decks consist of materials that may be aerosolized during removal. Particulate matter containing aluminum, titanium, silica, silicates, iron, barium sulfate, and fibrous glass have been identified in samples of nonskid material. Navy aviation boatswain's mate, and other occupational groups assigned aboard aircraft carriers may have had the greatest potential for exposure to aerosolized nonskid coatings, particularly during the 1970s. This study was performed to review the epidemiology of sarcoidosis and other chronic lung diseases diagnosed among Navy personnel and determine if occupational associations or time trends in incidence rates of hospitalized disease are consistent with an occupational etiology. Incidence rates based on first hospitalizations were calculated for black and white male active-duty enlisted personnel between 1975 and 2001. Hospitalized cases ascertained during this period included cases of sarcoidosis (n = 674), asthma (n = 3,536), emphysema and chronic bronchitis (n = 1,103), respiratory conditions due to fumes and vapors (n = 61), and pneumoconiosis (n = 51). Average annual sarcoidosis incidence rates per 100,000 for 1975-2001 were 24.9 for black males and 3.5 for white males, with a black/white ratio equal to 7.1. Incidence of sarcoidosis among male active-duty black enlisted personnel declined markedly over the study period, particularly since 1989, but the black white ratio remained high through 1999. Occupational associations were present among both white and black men. Black ships servicemen (23 cases) and black aviation structural mechanics specializing in structures (12 cases) had slightly more than twice the expected incidence of sarcoidosis in comparison with all black active-duty Navy male enlisted personnel. White Mess Management Specialists (15 cases) also had twice the expected incidence of sarcoidosis in comparison with all white active-duty Navy male enlisted personnel.

Introduction

Sarcoidosis is a multisystem granulomatous disease of unknown etiology. Its symptoms are highly variable and may involve any organ system, though over 90% of cases involve the lungs (1-3). Presenting signs of lung abnormalities found on chest radiograph include thoracic mediastinal widening, diffuse pulmonary and nodular infiltration, and bilateral hilar lymphadenopathy. Common respiratory symptoms such as cough and shortness of breath may accompany initial presentation (4-6). As many as one half of patients may be asymptomatic and are often discovered incidentally as a result of routine chest radiograph (2-4). In some patients, sarcoidosis appears for a period of 2-3 years and resolves, but 10-15% of patients may be chronically affected (5-7). Many cases are believed to resolve before they are recognized (4,5), but progression to fibrotic lung disease may occur. Some permanent lung damage occurs in approximately 20% of pulmonary cases, and the disease is fatal in 5-10% of cases where either the granulomas or fibrosis seriously affect the function of a vital organ (7).

Although a variety of environmental, occupational, infectious, and genetic risk factors have been suggested since the disorder was first documented in Europe 100 years ago, no single exposure has been found that accounts for the distribution of sarcoidosis (8). Sarcoidosis occurs in both sexes, all age groups, and all races (9-11). In the United States, sarcoidosis is found most commonly among 20- to 40-year-old adults. Prevalence is 8 times higher among blacks, approaching 40 per 100,000, with prevalence among whites estimated at about 5 per 100,000 (9-12). Individuals of Scandinavian, German, Irish, or Puerto Rican origin also appear to be at greater than average risk (8). Sarcoidosis was once thought to be rare in North America, but a large number of cases were identified in the military beginning in the mid-1940s during annual chest radiographic screening in the armed forces (4), a practice that has been greatly reduced since the mid-1970s. The systematic medical surveillance of military personnel that, until recently, included routine chest radiographs has led to several studies of sarcoidosis in military populations (4, 13-15). These and other epidemiological studies have identified higher risk for sarcoidosis in the Southeast and rural areas of the United States, but few other risk factors have been identified (16-20). Due to the variability of symptoms and population groups in which sarcoidosis can occur, diagnosis may be difficult and involves ruling out alternative diseases with similar signs or symptoms (21).

Although the identification of foreign bodies in granulomas is generally thought to exclude a diagnosis of sarcoidosis, a recent investigation using electron probe microanalysis found polarizable foreign bodies consisting of calcium, phosphorus, silicon, and aluminum in granulomatous skin lesions in some patients with cutaneous sarcoidosis. The authors suggested that the foreign body may have served as an inciting stimulus for granuloma formation in some cases of sarcoidosis (22).

Sarcoid-like granulomas of the lung have been reported in individuals exposed to glass fibers or rockwool, which are composed of silicates (23). One small case-control study found an odds ratio of 13.2 (95% confidence interval, 2.0 to140.9) in individuals who were occupationally or environmentally exposed to crystalline silica (cristobalite) from a plant that processed diatomaceous earth (24). A study conducted by the National Institute for Occupational Safety and Health suggested a possible relationship of sarcoidosis with assignment aboard aircraft carriers, and with removal of non-skid material, in particular (15). Nonskid coatings that have been used extensively on Navy ship decks and ramps. Particulate matter consisting of aluminum, titanium, silica, silicates, talc, iron, barium sulfate, and fibrous glass have been identified in two samples of nonskid material (25). Among numerous occupational groups, Navy boatswain's mates assigned to aircraft carriers may have had the greatest exposure to nonskid coatings. It is unknown to what degree this group is at risk for occupational lung disease and whether this group may be more likely to have a sarcoidosis diagnosis than other occupational groups. At the request of the U.S. Congress, the Secretary of the Navy, the Secretary of Veterans Affairs, and the Director of the Armed Forces Institute of Pathology, were directed to establish an occupational lung disease assessment program. The program's goal was to determine if naval personnel with lung disease due to other causes may have been misdiagnosed with sarcoidosis and if the incidence of sarcoidosis or other lung disease could be attributable to service aboard Navy ships. The Naval Health Research Center, San Diego, was designated by the Navy Bureau of Medicine and Surgery to manage the Navy Lung Disease Assessment Program.

Objectives

The objectives of the present epidemiological study are to examine the extent to which lung diseases, especially sarcoidosis, may have been misdiagnosed among Navy enlisted men

and to evaluate the relationship between sarcoidosis and service in Navy enlisted occupational groups. The study characterizes the incidence of sarcoidosis in active-duty Navy enlisted men according to race and Navy occupational specialty and describes incidence of sarcoidosis, pneumoconioses, and other lung diseases over time. The study includes special emphasis on determination of possible occupational associations and whether time trends in incidence were consistent with trends in surveillance procedures. The study also includes analysis of time trends in incidence of other chronic lung diseases in order to provide a context for the review of the epidemiology of sarcoidosis and examine the potential that changes in diagnostic practices over time may have had in explaining the decline in sarcoidosis incidence.

Methods

This study used an historical prospective design. Information from military service records was extracted to determine incidence rates of hospitalized sarcoidosis among Navy enlisted men according to age, race, navy enlisted occupational specialty, and hospitalization date. Incident cases of sarcoidosis, pneumoconioses, and other lung diseases were identified using the standard inpatient data record database of admissions to Department of Defense medical treatment facilities in recent years (1989-2001) and Navy data sources from 1975 to 1988. Detailed population data were available from 1975 to 2001. Age-specific incidence rates of first hospitalization for sarcoidosis, pneumoconioses, and other lung diseases were calculated according to race during the time period from 1975 to 2001. Race-specific standardized incidence ratios were used to compare age-adjusted hospitalized incidence rates in active-duty enlisted Navy men by occupation and race. Case ascertainment among active-duty Navy personnel included a broad range of lung disease diagnoses to accurately and completely assess time trends in incidence and evaluate the potential for shifts in diagnostic patterns over time. These cases were identified using the Department of Defense Executive Information Decision System standard inpatient data record, which includes admissions to military hospitals. Standard inpatient data record electronic records identify diagnoses in the *International Classification of Diseases, 9th edition,* format.

Demographic and other personnel information from other established military data sources was used to supplement the standard inpatient data record and validate personnel and demographic information. The main source for validation of career and demographic information

among active-duty military personnel in this study was the Defense Enrollment Eligibility Reporting System (DEERS), which is the central source for personnel information from the Department of Defense. This database is used to determine medical benefits eligibility, insurance, immunizations, and patient information. Records were merged into the Career History Archival Medical and Personnel System database created and maintained by the Naval Health Research Center. This system creates a longitudinal record for each individual. Diagnoses that were ascertained are listed in Table 1. The epidemiological analyses included a race-specific time trend study of lung disease incidence and a lung disease incidence study according to occupational designation.

Table 1. ICD-9 Lung Disease Codes Used for Case Ascertainment

Sarcoidosis (ICD-9 Code 135)
Pneumoconioses (ICD-9 Codes 501-505)
Respiratory conditions due to fumes and vapors (ICD-9 Code 506)
Emphysema and chronic bronchitis (ICD-9 Codes 491, 492)
Asthma (ICD-9 Code 493)

Demographic and service-related information for defining cohorts was obtained from the Defense Manpower Data Center in Monterey, CA. The Defense Manpower Data Center maintains detailed personnel records for all active-duty members of the armed forces including demographic information such as date of birth and race, as well as service-related information including: length of service, changes in duty assignments, occupational specialties and home of record. Information obtained for cases is listed in Table 2.

Table 2. Case Information Obtained

SSN or service number
Name
Date of birth
Date of accession
Date of first hospitalization and facility
Home of record
Diagnosis
Race (white, black, other)
Gender
Duty station assignments and dates (UIC, OBAC)
Occupational history (enlisted Navy rate, PNEC)
Date of end of service
Type of discharge (LOS code)

Statistical Analysis. Incidence rates of first hospitalization for sarcoidosis, pneumoconioses, and other lung diseases among active-duty Navy enlisted men were calculated according to race (white, black, other). Person-years were used in analyses aggregated across years and midyear population counts were used for time-trend analyses of annual incidence rates. Race-specific standardized incidence ratios using person-years were used to compare age-adjusted hospitalized incidence rates in active-duty Navy men by occupation and race (26). Age-specific sarcoidosis incidence rates for all white or all black Navy enlisted men were applied to the occupation-specific populations at risk stratified by race (black or white) to yield age-adjusted, race-stratified standardized incidence ratios for 115 Navy enlisted occupations. Ninety-five percent confidence intervals were calculated using the Poisson distribution (27). When needed, appropriate adjustment techniques were implemented to take into account multiple comparisons, providing both adjusted and unadjusted p values. Several of the above data sources and similar methods have been used to carry out previous epidemiological studies among active-duty Navy service members (28-35).

Results

Average annual age-specific incidence rates of lung disease based on first hospitalizations were calculated for black and white male active-duty enlisted personnel between 1975 and 2001. Population estimates based on midyear population counts were similar to person-years estimates for both black and white Navy enlisted personnel. Hospitalized incident cases ascertained during this period included cases of sarcoidosis (n = 674), asthma (n = 3,536), emphysema and chronic bronchitis (n = 1,103), respiratory conditions due to fumes and vapors (n = 61), and pneumoconioses (n = 51).

Age-specific incidence rates of sarcoidosis based on first hospitalization rates peaked among white men at ages 35-39 years (6.9 per 100,000) (Table 3). The highest incidence rates among black men occurred at younger ages, from 25-29 years of age (32.8 per 100,000). This study found a substantially higher sarcoidosis incidence rate among Navy enlisted blacks than whites, with the average annual rate per 100,000 equal to 24.9 among black men and 3.5 among whites. The overall black/white ratio was 7.1 ($p < 0.0001$). Higher incidence among blacks was most pronounced at younger ages.

In contrast to sarcoidosis, blacks had one-half the incidence rate of pneumoconiosis in comparison to whites but this difference was not statistically significant. A diagnosis of pneumoconiosis was rare in both races, with 47 hospitalized cases among whites and 4 cases among blacks (Table 4). The incidence rate of asthma requiring hospitalization was higher among blacks (48.5 per 100,000) than whites (31.2 per 100,000), with an overall black/white ratio of 1.5 ($p < 0.0001$) (Table 5). Serious cases of emphysema and chronic bronchitis that required hospitalization were twice as common among whites (12.0 per 100,000) as blacks (5.9 per 100,000; $p < 0.0001$) (Table 6). Lung injuries due to inhalation of fumes and vapors that were serious enough to require hospitalization were equally common among blacks as whites, with overall incidence equal to 0.6 per 100, 000 in both (Table 7).

Annual incidence rates of sarcoidosis based on midyear population counts declined steeply from 1975 to 2001 in both white and black Navy enlisted men, but the black/white ratio remained high through 1997 (Table 8). Sarcoidosis incidence rates dropped by more than 50% among blacks after 1975, when the Navy eliminated its requirement for most routine annual chest radiographs. Incidence in blacks dropped again after 1989, the year the Navy dropped its

requirement for chest radiography at Navy entrance and separation (Table 9). Declining trends in sarcoidosis in comparison with pneumoconiosis rates for white and black Navy personnel are shown in Tables 10 and 11. Pneumoconiosis rates were too low throughout the study period to account for the decline in sarcoidosis rates in either race. A diagnosis of pneumoconiosis was particularly rare in blacks, with only 4 cases diagnosed throughout the study period. Asthma was much more common in whites and blacks during the study period, but asthma incidence did not appear increase sufficiently among blacks during the study period to account for a contemporaneous decline in sarcoidosis incidence among blacks (Table 12). Likewise the trend in incidence rates of emphysema and chronic bronchitis and the low number of cases among blacks also were not sufficient to explain the marked decline in sarcoidosis incidence among blacks during the study period (Table 13).

Occupational associations were present among both white (Table 14) and black personnel (Table 15). Black ships servicemen (23 cases) and black aviation structural mechanics specializing in structures (12 cases) had slightly more than twice the expected incidence of sarcoidosis in comparison with all black active-duty Navy male enlisted personnel. White Mess Management Specialists (15 cases) also had twice the expected incidence of sarcoidosis in comparison with all white active-duty Navy male enlisted personnel.

Discussion

Although its cause is unknown, the epidemiology of sarcoidosis suggests that infectious agents or environmental factors could be important in its etiology (4,5,7-11,16). Like respiratory infections, seasonal occurrence of sarcoidosis symptoms has been reported with presentation more common during the winter and early spring (18,20). Cases have been reported to cluster in specific geographic regions and the disease is found more often in individuals living in rural locations (17,19, 36, 37).

Population-based epidemiological studies of sarcoidosis are complicated, however, by the suspected high prevalence of undetected cases and the wide variety of other lung disorders with similar clinical presentations but distinct etiologies. Beryllium disease was recognized as the cause of a cluster of sarcoidosis-like pulmonary disease initially diagnosed among young women employed in a fluorescent light factory in Salem, MA, in the 1940s (38). More recent studies described sarcoidosis-like pulmonary disease associated with exposure to silica compounds

(23,24), photocopier toner dust (39), titanium dioxide (40,41), aluminum dusts (42,43), and zirconium (44).

This study and previous investigations found a substantially higher sarcoidosis incidence rate, based on first hospitalization rates, for Navy enlisted blacks than for whites and a clear decline in hospitalized incidence rates for blacks over time. The average annual sarcoidosis incidence rates per 100,000 for 1975 to 2000 was 21.9 for black males and 3.5 for white males, with a black/white ratio equal to 7.2 (Table 3). These were lower-than-average annual incidence rates per 100,000 reported for black (29.8) and white men (9.6) in Detroit, MI, during 1990 to 1994 (12). In general, the lack of reliable population-based rates among U.S. civilians makes these comparisons problematic. Higher prevalence of sarcoidosis among blacks remains unexplained but a disproportionate exposure to environmental or infectious agents or a genetic predisposition has been suggested (45).

In a previous Naval Health Research Center report of sarcoidosis hospitalization among U.S. Navy and Marine Corps personnel during 1981 to 1995, race, age, and enlisted status were significantly associated with a higher risk for sarcoidosis (46). Blacks had 7.5 times the risk of hospitalization for sarcoidosis as whites, and age was positively associated with sarcoidosis risk. Enlisted personnel had approximately twice the risk of hospitalization for sarcoidosis as officers. The highest rates of sarcoidosis admissions occurred between 1981 and 1987 (8.3 per 100,000). Rates appeared to drop dramatically beginning in 1990 and declined to 2.5 per 100,000 in 1995.

This study provides a further basis to investigate the reasons for the temporal decline in rates in the Navy. Although the decline in sarcoidosis incidence in the Navy may reflect unrecognized trends in the general U.S. population, other potential explanations include unknown secular changes in population characteristics that may be associated with risk. Subtle changes in diagnostic criteria over time may have led to an apparent decline in sarcoidosis incidence observed in this study, if diseases formerly classified as sarcoidosis have been diagnosed as another lung disease. Pulmonary sarcoidosis symptoms may mimic symptoms of reactive airway disease (47). It is possible that some of the apparent decline in hospitalized sarcoidosis incidence in the Navy could be reflected in the increased incidence of asthma or other lung diseases with signs or symptoms similar to sarcoidosis over this time period (48). The lack of a contemporaneous increase in incidence of pneumoconioses, asthma, or emphysema and chronic bronchitis is evidence against this explanation.

Notably, the decline in sarcoidosis incidence parallels a decline in the intensity of surveillance practices in the Navy, specifically the frequency of routine chest radiography (Table 9). Clearly changes in diagnostic and medical screening procedures, particularly a reduction in the frequency of routine chest radiographs for enlisted personnel, could explain some of the secular decline in sarcoidosis incidence.

The decline in sarcoidosis incidence also may reflect changes in correlates of etiologic work-related exposures. These include changes in formulations of nonskid materials and use of respirators and other measures designed to counter dust exposure. This study found occupational associations present among both white and black Navy enlisted personnel. In particular, black ships servicemen (23 cases) had 2.3 times the expected incidence of sarcoidosis in comparison with all black Navy enlisted personnel and black aviation structural mechanics specializing in structures (12 cases) had approximately twice the expected incidence (Table 15). Aviation structural mechanics are routinely assigned to work aboard aircraft carriers and could be expected to have had some degree of occupational exposure to nonskid material resulting from removal operations.

Occupational assignment is a rough surrogate for any specific exposures that might be causally related to sarcoidosis or other lung diseases. However, the association of sarcoidosis with assignment to an aviation rating involving duty aboard aircraft carriers found in this and in a previous study (15) suggests two possibilities. The first explanation is that the diagnosis of a dust-related fibrotic lung disease was erroneously classified as sarcoidosis. This possibility is particularly apparent in blacks for whom a high index of diagnostic suspicion may have led to a differential tendency to classify a pneumoconiosis as sarcoidosis. The other explanation is that a previously unrecognized occupational association exists for sarcoidosis that is associated with service in an aviation rating. This possibility is worthy of further investigation, but would require better characterization of potential occupational exposures and environmental factors common to service in this occupation.

References

1. Fanburg BL, Lazarus DS. Sarcoidosis. In: Murray JF, Nadel JA, eds. Textbook of Respiratory Medicine, 2nd ed. Philadelphia: Saunders; 1994:1873-88.

2. Katz S. Clinical presentation and natural history of sarcoidosis. In: Fanburg BL, ed. Sarcoidosis and Other Granulomatous Diseases of the Lung. New York: Marcel Dekker; 1983:3-36.

3. Keller AZ. Anatomic sites, age attributes, and rates of sarcoidosis in US veterans. Am Rev Respir Dis. 1973;54:87-98.

4. Sartwell PE, Edwards LB. Epidemiology of sarcoidosis in the US Navy. Am J Epidemiol. 1974;99:250-7.

5. James DG, Turiaf I, Hosoda Y. Description of sarcoidosis: report of the Subcommittee on Classification and Definition. Ann N Y Acad Sci. 1976;278:742.

6. Sharma OP, Bijwadia J. Monitoring and treating sarcoid lung disease. J Respir Dis. 1993;14:750-60.

7. Keller AZ. Hospital, age, racial, occupational, geographical, clinical and survivorship characteristics in the epidemiology of sarcoidosis. Am J Epidemol. 1971;94:222-30.

8. Bresnitz EA, Strom BL. Epidemiology of sarcoidosis. Epidemiol Rev. 1983;5:124-56.

9. Cummings MM, Dunner E, Williams JH Jr. Epidemiologic and clinical observations in sarcoidosis. Ann Intern Med. 1959;50:879-90.

10. Cummings MM, Dunner E, Schmidt H Jr, Barnwell JB. Concepts of epidemiology of sarcoidosis. Postgrad Med. 1956;19:437-46.

11. James DG. Epidemiology of sarcoidosis. Sarcoidosis. 1992;9:79-87.

12. Rybicki BA, Major M, Popovich J Jr, Maliarik MJ, Iannuzzi MC. Racial differences in sarcoidosis incidence: a 5-year study in a health maintenance organization. Am J Epidemiol. 1997;145:234-41.

13. Cooch JW. Sarcoidosis in the U.S. Army, 1952 through 1956. Am Rev Respir Dis. 1961;84 (Suppl):103-8.

14. Gundelfinger BF, Britten SA. Sarcoidosis in the U.S. Navy. Am Rev Respir Dis. 1961;84 (Suppl):109-15.

15. Jajosky P. Sarcoidosis diagnoses among US military personnel: trends and ship assignment associations. Am J Prev Med. 1998;14:176-83.

16. Israel HL. Influence of race and geographical origin on sarcoidosis. Arch Environ Health. 1970;20:608-10.

17. Siltzbach LE. Geographic aspects of sarcoidosis. Trans N Y Acad Sci. 1967;29:364-74.

18. Badrinas F. Morera J, Fite E, Plasencia A. Seasonal clustering of sarcoidosis. Lancet. 1989;ii455-6.

19. Gentry JT, Nitowsky HM, Michael M Jr. Studies on the epidemiology of sarcoidosis in the United States: the relationship to soil areas and to urban/rural residence. J Clin Invest. 1955;34:1839-56.

20. Bresnitz EA, Stolley PD, Israel HL, Soper K. Possible risk factors for sarcoidosis: a case-control study. Ann N Y Acad Sci. 1986;465:632-42.

21. Hennessy TW, Ballard DJ, DeRemee RA, Chu CP, Melton LJ. The influence of diagnostic access bias on the epidemiology of sarcoidosis: a population-based study in Rochester, Minnesota, 1935-1984. J Clin Epidemiol. 1988;41:565-70.

22. Kim YC, Triffet MK, Gibson LE. Foreign bodies in sarcoidosis. Am J Dermatopathol. 2000;22:408-12.

23. Drent M, Bomans PH, Van Suylen RJ, Lamers RJ, Bast A, Wouters EF. Association of man-made mineral fibre exposure and sarcoidlike granulomas. Respir Med. 2000;94:815-20.

24. Rafnsson V, Ingimarsson O, Hjalmarsson I, Gunnarsdottir H. Association between exposure to crystalline silica and risk of sarcoidosis. Occup Environ Med. 1998;55:657-60.

25. Abraham JL, Panitz EB. Is sarcoidosis in the US Navy occupational lung disease from the grinding of non-skid paint aboard aircraft carriers? Analysis of inorganic particulates in lungs and a reference paint sample. Am J Respir Crit Care Med; 163(5)(Abstract Issue):A214.

26. Fleiss, JL. Statistical methods for rates and proportions. New York: John Wiley & Sons, 1981.

27. Lilienfeld DE, Stolley PD. Foundations of epidemiology, 3rd ed. New York: Oxford, 1994: 303.

28. Garland FC, Gorham ED, Garland CF. Hodgkin's disease in the U.S. Navy. International Journal of Epidemiology 1987;16:1-6.

29. Garland FC, Gorham ED, Garland CF. Non-Hodgkin's lymphomas in U.S. Navy personnel. Archives of Environmental Health 1988;43(6):425-9.

30. Garland FC, Gorham, ED, Garland CF, Ducatman AM. Testicular cancer in U.S. Navy aircraft and engine maintenance personnel. American Journal of Epidemiology 1988;127:411-4.

31. Garland FC, Shaw E, Gorham ED, Garland CF, White MW, Sinsheimer PJ. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy Personnel. American Journal of Epidemiology 1990;132:293-303.

32. Garland FC, White MW, Garland CF, Shaw EK, Gorham ED. Occupational sunlight exposure and melanoma in the U.S. Navy. Archives of Environmental Health 1990;45:261-7.

33. Garland FC, Gorham ED, Cunnion SO, Miller MR, Balazs LL, and the Navy HIV Working Group. Decline in Human Immunodeficiency Virus seropositivity and seroconversion in U.S. Navy enlisted personnel: 1986 to 1989. American Journal of Public Health 1992;82:581-4.

34. Gorham ED, Garland FC, Barrett-Connor E, Garland CF, Wingard DL, Pugh W. Incidence of insulin-dependent diabetes mellitus in young adults: experience of 1,587,630 US Navy enlisted personnel. American Journal of Epidemiology 1993;138:1-4.

35. Garland FC, Garland CF, Doyle EJ, Balazs L, Levine R, Pugh W, Gorham ED. Carpal tunnel syndrome and occupation in U.S. Navy enlisted personnel. Archives of Enviromental Health 1996;51(5):395-407.

36. Kajdasz, DK, Lackland DT, Mohr LC, Judson MA. A current assessment of rurally linked exposures as potential risk factors for sarcoidosis. Ann Epidemiol. 2001;11:111-7.

37. Kajdasz DK, Judson MA, Mohr LC, Lackland DT. Geographic variation in sarcoidosis in South Carolina: its relation to socioeconomic status and health care indicators. Am J Epidemiol. 1999;150:271-8.

38. Newman LS, Kreiss K, King TE, Seay S, Campbell PA. Pathologic and immunologic alterations in early stages of beryllium disease: re-examination of disease definition and natural history. Am Rev Respir Dis. 1989;139:1479-86.

39. Armbruster C, Dekan G, Hovorka A. Granulomatous pneumonitis and mediastinal lymphadenopathy due to photocopier toner dust. Lancet. 1996;348:690.

40. Pimentel JC. Systemic granulomatous disease, of the sarcoid type, caused by inhalation of titanium dioxide. Anatomo-clinical and experimental study. Acta Med Port. 1992;5:307-13.

41. Redline S, Barna BP, Tomashefski JF, Jr, Abraham JL. Granulomatous disease associated with pulmonary deposition of titanium. Br J Indian Med 1986;43:652-656.

42. DeVuyst P, Dumortier P, Schandene L, Estenne M, Verhest A, Yernault JC. Sarcoidlike lung granulomatosis induced by aluminum dusts. Am Rev Respir Dis. 1987:135:493-7.

43. Hull MJ, Abraham JL. Aluminum welding fume-induced pneumoconiosis. Hum Pathol 2002 Aug;33(8):819-25

44. Kotter JM, Zieger G. Sarcoid granulomatosis after many years of exposure to zirconium, "zirconium lung." Pathologe. 1992;13:104-9.

45. Centers for Disease Control. Sarcoidosis among U.S. Navy enlisted men, 1965-1993. MMWR Morb Mortal Wkly Rep. 199713;46:539-43.

46. McDonough C, Gray GC. Risk factors for sarcoidosis hospitalization among U.S. Navy and Marine Corps personnel, 1981 to 1995. Mil Med. 2000;165:630-2.

47. Pesola GR, Kurdi M, Olibrice M. Endobronchial sarcoidosis and hyperreactive airways disease. Chest. 2002;121:2081.

48. Connolly JP, Baez SA. Asthma in the Navy and Marine Corps. Mil Med. 1991;156:461-5.

Table 3. Sarcoidosis (ICD-9 Code 135) incidence (first hospitalization) rates by age and race, active-duty men, U.S. Navy, 1975-2001

	White					Black					
				95% Confidence Interval*					95% Confidence Interval*		Black/ White
Age	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	Ratio
< 20	6	660,998	0.9	0.3	2.0	16	107,989	14.8	8.5	24.0	16.3
20-24	85	3,502,935	2.4	1.9	3.0	137	649,594	21.1	17.8	25.0	8.7
25-29	78	1,757,398	4.4	3.5	5.6	119	362,271	32.8	27.3	39.5	7.4
30-34	43	1,151,774	3.7	2.7	5.0	66	209,127	31.6	24.6	40.5	8.5
35-39	62	904,587	6.9	5.3	8.9	26	131,354	19.8	12.9	29.1	2.9
40-44	18	344,241	5.2	3.1	8.3	13	45,845	28.4	15.1	48.5	5.4
45-49	3	92,667	3.2	0.7	7.1	1	10,020	10.0	0.3	55.6	3.1
50-54	1	17,209	5.8	0.1	32.4	0	1,163	0.0	0.0	258.0	0.0
55-59	0	3,633	0.0	0.0	82.6	0	122	0.0	0.0	2459.0	...
60-64	0	643	0.0	0.0	466.6	0	41	0.0	0.0	7317.1	...
All ages	296	8,436,084	3.5	3.1	3.9	378	1,517,523	24.9	22.5	27.6	7.1

* 95% confidence intervals are based on the Poisson distribution (26).

Table 4. Pneumoconioses (ICD-9 Codes 501-505) incidence (first hospitalization) rates by age and race, active-duty men, U.S. Navy, 1975-2001

	White					Black					
Age	No. of Cases	Population (Person-Years)	Incidence Rate	95% Confidence Interval* Lower	Upper	No. of Cases	Population (Person-Years)	Incidence Rate	95% Confidence Interval* Lower	Upper	Black/ White Ratio
< 20	4	660,998	0.6	0.2	1.5	0	107,989	0.0	0.0	2.8	0.0
20-24	10	3,502,935	0.3	0.1	0.5	2	649,594	0.3	0.0	1.1	1.1
25-29	9	1,757,398	0.5	0.2	1.0	1	362,271	0.3	0.0	1.5	0.5
30-34	5	1,151,774	0.4	0.1	1.0	1	209,127	0.5	0.0	2.7	1.1
35-39	6	904,587	0.7	0.2	1.4	0	131,354	0.0	0.0	2.3	0.0
40-44	7	344,241	2.0	0.8	4.2	0	45,845	0.0	0.0	6.5	0.0
45-49	4	92,667	4.3	1.2	11.1	0	10,020	0.0	0.0	29.9	0.0
50-54	1	17,209	5.8	0.1	32.4	0	1,163	0.0	0.0	258.0	0.0
55-59	1	3,633	27.5	0.7	153.3	0	122	0.0	0.0	2459.0	0.0
60-64	0	643	0.0	0.0	466.6	0	41	0.0	0.0	7317.1	...
All ages	47	8,436,084	0.6	0.4	0.7	4	1,517,523	0.3	0.1	0.7	0.5

* 95% confidence intervals are based on the Poisson distribution (26).

Table 5. Asthma (ICD-9 Code 493) incidence (first hospitalization) rates by age and race, active-duty men, U.S. Navy, 1975-2001

	White					Black					
				95% Confidence Interval*					95% Confidence Interval*		Black/ White
Age	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	Ratio
< 20	490	660,998	74.1	67.8	81.1	120	107,989	111.1	92.6	133.3	1.5
20-24	1,026	3,502,935	29.3	27.5	31.2	312	649,594	48.0	42.9	53.7	1.6
25-29	483	1,757,398	27.5	25.1	30.1	149	362,271	41.1	34.9	48.5	1.5
30-34	311	1,151,774	27.0	24.1	30.2	77	209,127	36.8	29.2	46.2	1.4
35-39	299	904,587	33.1	29.5	37.1	47	131,354	35.8	26.3	47.7	1.1
40-44	139	344,241	40.4	34.1	47.8	26	45,845	56.7	37.0	83.4	1.4
45-49	40	92,667	43.2	30.8	58.7	4	10,020	39.9	10.9	102.2	0.9
50-54	7	17,209	40.7	16.3	83.8	1	1,163	86.0	2.2	478.9	2.1
55-59	5	3,633	137.6	44.6	320.7	0	122	0.0	0.0	2459.0	0.0
60-64	0	643	0.0	0.0	466.6	0	41	0.0	0.0	7317.1	...
All ages	2,800	8,436,084	33.2	31.2	35.3	736	1,517,523	48.5	45.1	52.2	1.5

* 95% confidence intervals are based on the Poisson distribution (26).

Table 6. Emphysema & Chronic Bronchitis (ICD-9 Codes 491,492) incidence (first hospitalization) rates by age and race, active-duty men, U.S. Navy, 1975-2001

	White					Black					
				95% Confidence Interval*					95% Confidence Interval*		Black/ White
Age	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	No. of Cases	Population (Person-Years)	Incidence Rate	Lower	Upper	Ratio
< 20	90	660,998	13.6	11.0	16.9	7	107,989	6.5	2.6	13.4	0.5
20-24	195	3,502,935	5.6	4.8	6.4	30	649,594	4.6	3.1	6.6	0.8
25-29	118	1,757,398	6.7	5.6	8.1	14	362,271	3.9	2.1	6.5	0.6
30-34	123	1,151,774	10.7	8.9	12.8	13	209,127	6.2	3.3	10.6	0.6
35-39	213	904,587	23.5	20.5	27.0	11	131,354	8.4	4.2	15.0	0.4
40-44	143	344,241	41.5	35.1	49.1	5	45,845	10.9	3.5	25.4	0.3
45-49	73	92,667	78.8	62.1	99.6	8	10,020	79.8	34.4	157.3	1.0
50-54	43	17,209	249.9	180.7	336.8	1	1,163	86.0	2.2	478.9	0.3
55-59	12	3,633	330.3	170.8	578.0	1	122	819.7	20.7	4565.6	2.5
60-64	2	643	311.0	37.6	1122.9	0	41	0.0	0.0	7317.1	0.0
All ages	1,012	8,436,084	12.0	11.3	12.8	90	1,517,523	5.9	4.8	7.4	0.5

* 95% confidence intervals are based on the Poisson distribution (26).

Table 7. Respiratory conditions due to fumes and vapors (ICD-9 Code 506) incidence (first hospitalization) rates by age and race, active-duty men, U.S. Navy, 1975-2001

	White					Black					
Age	No. of Cases	Population (Person-Years)	Incidence Rate	95% Confidence Interval* Lower	Upper	No. of Cases	Population (Person-Years)	Incidence Rate	95% Confidence Interval* Lower	Upper	Black/ White Ratio
< 20	6	660,998	0.9	0.3	2.0	3	107,989	2.8	0.6	10.0	3.1
20-24	22	3,502,935	0.6	0.4	0.9	2	649,594	0.3	0.0	1.1	0.5
25-29	9	1,757,398	0.5	0.2	1.0	1	362,271	0.3	0.0	1.5	0.5
30-34	9	1,151,774	0.8	0.4	1.5	2	209,127	1.0	0.1	3.5	1.2
35-39	5	904,587	0.6	0.2	1.3	1	131,354	0.8	0.0	4.2	1.4
40-44	0	344,241	0.0	0.0	0.9	0	45,845	0.0	0.0	6.5	...
45-49	0	92,667	0.0	0.0	3.2	0	10,020	0.0	0.0	29.9	...
50-54	1	17,209	5.8	0.1	32.4	0	1,163	0.0	0.0	258.0	0.0
55-59	0	3,633	0.0	0.0	82.6	0	122	0.0	0.0	2459.0	...
60-64	0	643	0.0	0.0	466.6	0	41	0.0	0.0	7317.1	...
All ages	52	8,436,084	0.6	0.5	0.8	9	1,517,523	0.6	0.3	1.1	1.0

* 95% confidence intervals are based on the Poisson distribution (26).

Table 8. Annual incidence (first hospitilization) rates for sarcoidosis (ICD-9 Code 135), among white and black Navy enlisted men by year, 1975-2001

	White			Black			Black / White Ratio
Year	No. of Cases	Midyear Population	Incidence Rate	No. of Cases	Midyear Population	Incidence Rate	
1975	15	359,920	4.2	25	35,517	70.4	16.9
1976	22	377,109	5.8	15	34,574	43.4	7.4
1977	16	373,134	4.3	11	36,891	29.8	7.0
1978	17	370,433	4.6	20	39,730	50.3	11.0
1979	17	362,629	4.7	14	43,119	32.5	6.9
1980	16	354,504	4.5	16	47,585	33.6	7.4
1981	11	357,210	3.1	14	50,792	27.6	9.0
1982	11	354,110	3.1	17	52,295	32.5	10.5
1983	9	363,162	2.5	18	55,815	32.2	13.0
1984	18	371,315	4.8	16	58,034	27.6	5.7
1985	9	370,434	2.4	16	59,019	27.1	11.2
1986	8	369,805	2.2	15	61,140	24.5	11.3
1987	15	353,306	4.2	26	66,476	39.1	9.2
1988	12	368,174	3.3	21	68,559	30.6	9.4
1989	21	369,186	5.7	17	73,749	23.1	4.1
1990	7	229,901	3.0	21	76,988	27.3	9.0
1991	13	359,003	3.6	18	78,694	22.9	6.3
1992	16	337,498	4.7	12	75,275	15.9	3.4
1993	12	314,165	3.8	7	70,421	9.9	2.6
1994	4	288,115	1.4	17	65,140	26.1	18.8
1995	6	261,161	2.3	7	60,927	11.5	5.0
1996	4	245,185	1.6	11	59,377	18.5	11.4
1997	3	225,214	1.3	8	56,775	14.1	10.6
1998	5	211,083	2.4	6	54,978	10.9	4.6
1999	4	199,200	2.0	5	53,895	9.3	4.6
2000	1	195,143	0.5	1	54,150	1.8	3.6
2001	4	191,970	2.1	4	55,216	7.2	3.5
1975-2001	296	8,532,069	3.5	378	1,545,131	24.5	7.1

Table 9. Incidence (first hospitilization) rates for sarcoidosis (ICD-9 Code 135) among white and black Navy enlisted men and year of change in Navy requirements for routine chest radiography associated with service entry, separation and tuberculosis skin test (TBSK) screening results, 1975-2001

	Routine Chest Radiography Requirement				White			Black			
	At	Annual TB Screening		At	No. of	Sum of Midyear		No. of	Sum of Midyear		Black / White
Year	Entry	TBSK+	TBSK-	Separation	Cases	Populations	Incidence Rate	Cases	Populations	Incidence Rate	Ratio
1975*	Yes	Yes	Yes	Yes	15	359,920	4.2	25	35,517	70.4	16.9
1976-86 #	Yes	No	Yes	Yes	154	4,023,845	3.8	172	538,994	31.9	8.3
1987-89 ‡	Yes	No	No	Yes	48	1,090,666	4.4	64	208,784	30.7	7.0
1990-99	No	No	No	No	74	2,670,525	2.8	112	652,470	17.2	6.2
2000-01	No	No	No	No	5	387,113	1.3	5	109,366	4.6	3.5
1975-2001					296	8,532,069	3.5	378	1,545,131	24.5	7.1

* August 1975--Navy Medicine "Tuberculosis Control Program" instruction eliminated the requirement for most routine annual chest radiographs.

October 1986--Navy Medicine "Tuberculosis Control Program" instruction eliminated the requirement for annual chest radiograph of known tuberculosis skin test reactors who remain asymptomatic.

‡ April 1989 --Navy Medicine message eliminated the requirement for chest radiograph as part of the tuberculosis control program upon entry to Naval service and for the separation physical.

Table 10. Sarcoidosis (ICD-9 Code 135) and pneumoconiosis (ICD-9 Codes 501-505) incidence rates per 100,000 person-years, white men, active-duty U.S. Navy enlisted personnel, 1975-2001

	Sarcoidosis			Pneumoconiosis			Sarcoidosis/
Year	No. of Cases	Midyear Population	Incidence Rate	No.of Cases	Midyear Population	Incidence Rate	Pneumoconiosis Ratio
1975	15	359,920	4.2	3	359,920	0.8	5.0
1976	22	377,109	5.8	2	377,109	0.5	11.0
1977	16	373,134	4.3	2	373,134	0.5	8.0
1978	17	370,433	4.6	3	370,433	0.8	5.7
1979	17	362,629	4.7	0	362,629	0.0	...
1980	16	354,504	4.5	2	354,504	0.6	8.0
1981	11	357,210	3.1	5	357,210	1.4	2.2
1982	11	354,110	3.1	0	354,110	0.0	...
1983	9	363,162	2.5	4	363,162	1.1	2.3
1984	18	371,315	4.8	4	371,315	1.1	4.5
1985	9	370,434	2.4	3	370,434	0.8	3.0
1986	8	369,805	2.2	1	369,805	0.3	8.0
1987	15	353,306	4.2	1	353,306	0.3	15.0
1988	12	368,174	3.3	2	368,174	0.5	6.0
1989	21	369,186	5.7	4	369,186	1.1	5.3
1990	7	229,901	3.0	1	229,901	0.4	7.0
1991	13	359,003	3.6	0	359,003	0.0	...
1992	16	337,498	4.7	1	337,498	0.3	16.0
1993	12	314,165	3.8	2	314,165	0.6	6.0
1994	4	288,115	1.4	3	288,115	1.0	1.3
1995	6	261,161	2.3	0	261,161	0.0	...
1996	4	245,185	1.6	2	245,185	0.8	2.0
1997	3	225,214	1.3	0	225,214	0.0	...
1998	5	211,083	2.4	1	211,083	0.5	5.0
1999	4	199,200	2.0	0	199,200	0.0	...
2000	1	195,143	0.5	1	195,143	0.5	1.0
2001	4	191,970	2.1	0	191,970	0.0	...
1975-2001	296	8,532,069	3.5	47	8,532,069	0.6	6.3

Table 11. Sarcoidosis (ICD-9 Code 135) and pneumoconiosis (ICD-9 Codes 501-505) incidence rates per 100,000 person-years, black men, active-duty U.S. Navy enlisted personnel, 1975-2001

	Sarcoidosis			Pneumoconiosis			Sarcoidosis/
Year	No. of Cases	Midyear Population	Incidence Rate	No. of Cases	Midyear Population	Incidence Rate	Pneumoconiosis Ratio
1975	25	35,517	70.4	0	35,517	0.0	...
1976	15	34,574	43.4	1	34,574	2.9	15.0
1977	11	36,891	29.8	0	36,891	0.0	...
1978	20	39,730	50.3	0	39,730	0.0	...
1979	14	43,119	32.5	0	43,119	0.0	...
1980	16	47,585	33.6	0	47,585	0.0	...
1981	14	50,792	27.6	0	50,792	0.0	...
1982	17	52,295	32.5	0	52,295	0.0	...
1983	18	55,815	32.2	0	55,815	0.0	...
1984	16	58,034	27.6	0	58,034	0.0	...
1985	16	59,019	27.1	0	59,019	0.0	...
1986	15	61,140	24.5	0	61,140	0.0	...
1987	26	66,476	39.1	0	66,476	0.0	...
1988	21	68,559	30.6	1	68,559	1.5	21.0
1989	17	73,749	23.1	0	73,749	0.0	...
1990	21	76,988	27.3	0	76,988	0.0	...
1991	18	78,694	22.9	0	78,694	0.0	...
1992	12	75,275	15.9	0	75,275	0.0	...
1993	7	70,421	9.9	0	70,421	0.0	...
1994	17	65,140	26.1	1	65,140	1.5	17.0
1995	7	60,927	11.5	0	60,927	0.0	...
1996	11	59,377	18.5	1	59,377	1.7	11.0
1997	8	56,775	14.1	0	56,775	0.0	...
1998	6	54,978	10.9	0	54,978	0.0	...
1999	5	53,895	9.3	0	53,895	0.0	...
2000	1	54,150	1.8	0	54,150	0.0	...
2001	4	55,216	7.2	0	55,216	0.0	...
1975-2001	378	1,545,131	24.5	4	1,545,131	0.3	94.5

Table 12. Asthma (ICD-9 Code 493) incidence (first hospitalization) rates per 100,000 person-years, by race and year, active-duty Navy enlisted white and black men, 1975-2001

	White			Black			Black / White Ratio
Year	No. of Cases	Midyear Population	Incidence Rate	No. of Cases	Midyear Population	Incidence Rate	
1975	140	359,920	38.9	21	35,517	59.1	1.5
1976	121	377,109	32.1	28	34,574	81.0	2.5
1977	111	373,134	29.7	23	36,891	62.3	2.1
1978	100	370,433	27.0	22	39,730	55.4	2.1
1979	102	362,629	28.1	15	43,119	34.8	1.2
1980	111	354,504	31.3	30	47,585	63.0	2.0
1981	112	357,210	31.4	20	50,792	39.4	1.3
1982	131	354,110	37.0	28	52,295	53.5	1.4
1983	103	363,162	28.4	27	55,815	48.4	1.7
1984	116	371,315	31.2	26	58,034	44.8	1.4
1985	114	370,434	30.8	32	59,019	54.2	1.8
1986	99	369,805	26.8	31	61,140	50.7	1.9
1987	110	353,306	31.1	24	66,476	36.1	1.2
1988	99	368,174	26.9	26	68,559	37.9	1.4
1989	123	369,186	33.3	37	73,749	50.2	1.5
1990	116	229,901	50.5	33	76,988	42.9	0.8
1991	139	359,003	38.7	32	78,694	40.7	1.1
1992	108	337,498	32.0	28	75,275	37.2	1.2
1993	138	314,165	43.9	27	70,421	38.3	0.9
1994	113	288,115	39.2	46	65,140	70.6	1.8
1995	94	261,161	36.0	42	60,927	68.9	1.9
1996	118	245,185	48.1	38	59,377	64.0	1.3
1997	68	225,214	30.2	30	56,775	52.8	1.8
1998	53	211,083	25.1	19	54,978	34.6	1.4
1999	70	199,200	35.1	19	53,895	35.3	1.0
2000	54	195,143	27.7	16	54,150	29.5	1.1
2001	37	191,970	19.3	16	55,216	29.0	1.5
1975-2001	2,800	8,532,069	32.8	736	1,545,131	47.6	1.5

Table 13. Annual Incidence (first hospitilization) rates for Emphysema and Chronic Bronchitis (ICD-9 Codes 491, 492), among white and black Navy enlisted men, by year, 1975 - 2001

	White			Black			Black /
Year	No. of Cases	Midyear Population	Incidence Rate	No. of Cases	Midyear Population	Incidence Rate	White Ratio
1975	62	359,920	17.2	5	35,517	14.1	0.8
1976	66	377,109	17.5	4	34,574	11.6	0.7
1977	41	373,134	11.0	1	36,891	2.7	0.2
1978	37	370,433	10.0	4	39,730	10.1	1.0
1979	32	362,629	8.8	2	43,119	4.6	0.5
1980	50	354,504	14.1	2	47,585	4.2	0.3
1981	39	357,210	10.9	1	50,792	2.0	0.2
1982	58	354,110	16.4	4	52,295	7.6	0.5
1983	42	363,162	11.6	2	55,815	3.6	0.3
1984	44	371,315	11.8	0	58,034	0.0	0.0
1985	32	370,434	8.6	3	59,019	5.1	0.6
1986	49	369,805	13.3	4	61,140	6.5	0.5
1987	46	353,306	13.0	3	66,476	4.5	0.3
1988	43	368,174	11.7	6	68,559	8.8	0.7
1989	45	369,186	12.2	6	73,749	8.1	0.7
1990	51	229,901	22.2	3	76,988	3.9	0.2
1991	37	359,003	10.3	4	78,694	5.1	0.5
1992	37	337,498	11.0	6	75,275	8.0	0.7
1993	42	314,165	13.4	4	70,421	5.7	0.4
1994	30	288,115	10.4	2	65,140	3.1	0.3
1995	36	261,161	13.8	6	60,927	9.8	0.7
1996	28	245,185	11.4	5	59,377	8.4	0.7
1997	14	225,214	6.2	4	56,775	7.0	1.1
1998	15	211,083	7.1	3	54,978	5.5	0.8
1999	13	199,200	6.5	3	53,895	5.6	0.9
2000	13	195,143	6.7	3	54,150	5.5	0.8
2001	10	191,970	5.2	0	55,216	0.0	0.0
1975-2001	1012	8,532,069	11.9	90	1,545,131	5.8	0.5

Table 14. Sarcoidosis (ICD9 Code 135) incidence (first hospitalization) rates per 100,000 person-years and standardized incidence ratios by occupation, Navy enlisted white men, 1 January 1975 - 30 June 2001*

Occupation	Code	Description	No. of Observed Cases	No. of Person-Years	Incidence Rate	No. of Expected Cases	Standardized Incidence Ratio	95% Confidence Interval	
								Lower	Upper
0100	BM	BOATSWAINS MATE	6	186,869	3.2	7.8	0.8	0.3	1.7
0150	MA	MASTER-AT-ARMS	2	27,621	7.2	1.4	1.5	0.2	5.3
0200	QM	QUARTERMASTER	3	87,750	3.4	3.3	0.9	0.2	2.6
0250	SM	SIGNALMAN	4	56,544	7.1	2.1	1.9	0.5	5.0
0300	OS	OPERATIONS SPECIALIST	10	211,541	4.7	7.5	1.3	0.6	2.5
0350	EW	ELECTRONICS WARFARE TECHNICIAN	2	55,061	3.6	2.0	1.0	0.1	3.6
0400	ST	SONAR TECHNICIAN	0	898	0.0	0.1	0.0	0.0	-
0401	SG	SONAR TECHNICIAN-SURFACE	0	110,887	0.0	3.9	0.0	0.0	-
0404	SS	SONAR TECHNICIAN-SUBMARINE	3	74,367	4.0	2.8	1.1	0.2	3.2
0450	OT	OCEAN SYSTEMS TECHNICIAN	0	10,752	0.0	0.4	0.0	0.0	-
0451	OT	OCEAN SYSTEMS TECHNICIAN, ANALYST	0	8,680	0.0	0.4	0.0	0.0	-
0452	OT	OCEAN SYSTEMS TECHNICIAN, MAINTENANCE	0	2,639	0.0	0.1	0.0	0.0	-
0500	TM	TORPEDOMANS MATE (SUB-SURFACE/SURFACE)	3	70,133	4.3	2.7	1.1	0.2	3.3
0600	GM	GUNNERS MATE	0	24,805	0.0	1.2	0.0	0.0	-
0601	G1	GUNNERS MATE-MISSILES	1	31,764	3.2	1.1	0.9	0.0	5.0
0602	GT	GUNNERS MATE-TECHNICIAN	0	19,223	0.0	0.7	0.0	0.0	-
0604	GG	GUNNERS MATE-GUNS	1	76,326	1.3	2.8	0.4	0.0	2.0
0700	FC	FIRE CONTROLMAN	2	113,569	1.8	4.5	0.5	0.1	1.6
0800	FT	FIRE CONTROL TECHNICIAN	1	15,880	6.3	0.8	1.3	0.0	7.2
0801	FG	FIRE CONTROL TECHNICIAN-GUN	3	49,381	6.1	1.7	1.8	0.4	5.1
0802	FM	FIRE CONTROL TECHNICIAN-SURFACE MISSILE	2	34,528	5.8	1.2	1.7	0.2	6.2
0803	FB	FIRE CONTROL TECHNICIAN-BALLISTIC MISSILE	1	15,743	6.4	0.6	1.8	0.0	9.9
0810	MT	MISSILE TECHNICIAN	1	42,525	2.4	1.6	0.6	0.0	3.5
0900	MN	MINEMAN	0	12,769	0.0	0.5	0.0	0.0	-
1000	ET	ELECTRONICS TECHNICIAN	8	380,912	2.1	14.6	0.6	0.2	1.1
1001	E1	ELECTRONICS TECHNICIAN-COMMUNICATIONS	3	25,352	11.8	0.7	4.1	0.8	12.0
1002	E2	ELECTRONICS TECHNICIAN-RADAR	0	21,086	0.0	0.6	0.0	0.0	-
1010	DS	DATA SYSTEMS TECHNICIAN	1	49,363	2.0	1.9	0.5	0.0	3.0
1080	PI	PRECISION INSTRUMENTMAN	0	92	0.0	0.0	0.0	0.0	-
1100	IM	INSTRUMENTMAN	1	10,146	9.9	0.4	2.5	0.1	14.0
1200	OM	OPTICALMAN	0	6,625	0.0	0.3	0.0	0.0	-
1400	NC	NAVY COUNSELOR	1	27,540	3.6	1.5	0.7	0.0	3.8
1500	RM	RADIOMAN CHANGE TO (IT)	7	260,471	2.7	9.9	0.7	0.3	1.5
1600	C2	CTR/CTT COMBINATION	0	0	-	0.0	-	0.0	-
1611	CT	CRYPTOLOGIC TECH-TECHNICAL	1	31,691	3.2	1.3	0.8	0.0	4.4
1622	CA	CRYPTOLOGIC TECH-ADMINISTRATIVE	1	15,206	6.6	0.6	1.6	0.0	8.8
1633	C1	CRYPTOLOGIC TECH-MAINTENANCE	2	42,920	4.7	1.7	1.2	0.1	4.3

1644	CO	CRYPTOLOGIC TECH-COMMUNICATIONS	3	34,156	5.9	1.3	2.3	0.5	6.7
1655	CR	CRYPTOLOGIC TECH-COLLECTION	1	44,657	2.2	1.8	0.6	0.0	3.1
1666	CI	CRYPTOLOGIC TECH-INTERPRETIVE	1	24,594	4.1	1.0	1.0	0.0	5.4
1700	YN	YEOMAN	7	159,272	4.4	6.6	1.1	0.4	2.2
1750	LN	LEGALMAN	0	6,923	0.0	0.3	0.0	0.0	-
1800	PN	PERSONNELMAN	7	98,523	7.1	4.1	1.7	0.7	3.6
1900	DP	DATA PROCESSING TECHNICIAN CHANGED TO (IT)	3	49,189	6.1	1.9	1.6	0.3	4.5
2000	SK	STOREKEEPER	6	128,813	4.7	5.1	1.2	0.4	2.6
2100	DK	DISBURSING CLERK	1	30,102	3.3	1.2	0.9	0.0	4.9
2200	MS	MESS MANAGEMENT SPECIALIST	15	202,003	6.9	7.4	2.0	1.1	3.4
2300	IS	INTELLIGENCE SPECIALIST	2	30,699	6.5	1.2	1.7	0.2	6.2
2490	SH	SHIPS SERVICEMAN	4	52,302	7.7	1.9	2.1	0.6	5.3
2500	RP	RELIGIOUS PROGRAMS SPECIALIST	0	9,330	0.0	0.4	0.0	0.0	-
2600	JO	JOURNALIST	0	14,756	0.0	0.6	0.0	0.0	-
2700	PC	POSTAL CLERK	0	17,466	0.0	0.7	0.0	0.0	-
3100	LI	LITHOGRAPHER	0	7,309	0.0	0.3	0.0	0.0	-
3200	DM	ILLUSTRATOR DRAFTSMAN	0	4,780	0.0	0.2	0.0	0.0	-
3300	MU	MUSICIAN	3	28,198	10.6	1.0	3.0	0.6	8.8
3600	SR	SEAMAN RECRUIT	10	754,724	1.3	16.1	0.6	0.3	1.2
3700	MM	MACHINISTS MATE	21	572,796	3.7	20.0	1.1	0.7	1.6
3800	EN	ENGINEMAN	9	168,128	5.4	6.2	1.5	0.7	2.8
3900	MR	MACHINERY REPAIRMAN	1	49,623	0.0	1.8	0.6	0.0	3.1
4000	BT	BOILER TECHNICIAN-AT E6, MAY OPT FOR BR	6	177,649	3.4	6.2	1.0	0.4	2.1
4020	BR	BOILERMAKER	0	218	0.0	0.0	0.0	0.0	-
4100	EM	ELECTRICIANS MATE	6	258,016	1.9	9.0	0.7	0.3	1.5
4200	IC	INTERIOR COMMUNICATIONS ELECTRICIAN	3	111,970	2.7	4.1	0.7	0.2	2.2
4300	HT	HULL MAINTENANCE TECHNICIAN	6	218,134	2.3	7.8	0.8	0.3	1.7
4400	GS	GAS TURBINE SYSTEM TECHNICIAN	1	2,808	35.6	0.2	6.1	0.2	33.9
4401	G2	GAS TURBINE SYSTEM TECHNICIAN - ELECTRICAL	0	20,933	0.0	0.8	0.0	0.0	-
4402	G3	GAS TURBINE SYSTEM TECHNICIAN - MECHANICAL	1	40,066	2.5	1.5	0.7	0.0	3.8
4500	DC	DAMAGE CONTROLMAN	1	46,485	2.2	1.8	0.6	0.0	3.1
4600	PM	PATTERNMAKER	0	2,794	0.0	0.1	0.0	0.0	-
4700	ML	MOLDER	0	4,215	0.0	0.2	0.0	0.0	-
5000	FR	FIREMAN RECRUIT	5	317,365	1.6	6.8	0.7	0.2	1.7
5080	CU	CONSTRUCTIONMAN	0	991	0.0	0.1	0.0	0.0	-
5100	EA	ENGINEERING AID	1	6,492	15.4	0.3	4.0	0.1	22.5
5300	CE	CONSTRUCTION ELECTRICIAN	2	29,185	6.9	1.1	1.9	0.2	6.7
5380	EQ	EQUIPMENTMAN	0	675	0.0	0.0	0.0	0.0	-
5410	EO	EQUIPMENT OPERATOR	2	46,733	4.3	1.7	1.2	0.1	4.3
5500	CM	CONSTRUCTION MECHANIC	3	36,761	8.2	1.3	2.2	0.5	6.5
5600	BU	BUILDER	3	65,050	4.6	2.3	1.3	0.3	3.7
5700	SW	STEELWORKER	0	21,641	0.0	0.8	0.0	0.0	-
5800	UT	UTILITIES MAN	1	28,171	3.6	1.0	1.0	0.0	5.4

6000	CN	CONSTRUCTIONMAN	0	10,132	0.0	0.2	0.0	0.0	-
6080	AF	AIRCRAFT MAINTENANCE TECHNICIAN	0	7,261	0.0	0.4	0.0	0.0	-
6180	AV	AVIONICS TECHNICIAN	0	7,181	0.0	0.4	0.0	0.0	-
6200	AD	AVIATION MACHINISTS MATE	12	194,752	6.2	7.5	1.6	0.8	2.8
6205	A5	AVIATION MACHINISTS MATE-RECIPROCATING ENGINES	0	5,983	0.0	0.3	0.0	0.0	-
6206	A4	AVIATION MACHINISTS MATE-JET ENGINES	0	29,558	0.0	1.1	0.0	0.0	-
6300	AT	AVIATION ELECTRONICS TECHNICIAN	11	268,554	4.1	10.5	1.1	0.5	1.9
6310	AX	ANTISUBMARINE WARFARE TECHNICIAN	2	34,662	5.8	1.3	1.5	0.2	5.5
6400	AW	AVIATION ASW OPERATOR (ACOUSTIC/NON-ACOUSTIC)	0	77,324	0.0	3.0	0.0	0.0	-
6500	AO	AVIATION ORDNANCEMAN	4	142,391	2.8	5.2	0.8	0.2	2.0
6520	AQ	AVIATION FIRE CONTROL TECHNICIAN	1	46,935	2.1	1.7	0.6	0.0	3.2
6600	AC	AIR TRAFFIC CONTROLLER	2	51,176	3.9	2.0	1.0	0.1	3.6
6700	AB	AVIATION BOATSWAINS MATE	0	2,360	0.0	0.1	0.0	0.0	-
6704	A1	AVIATION BOATSWAINS MATE-LAUNCH/RECOVERY EQUIPMENT	1	37,275	2.7	1.3	0.8	0.0	4.3
6705	A3	AVIATION BOATSWAINS MATE-FUELS	2	30,578	6.5	1.1	1.9	0.2	6.7
6706	A2	AVIATION BOATSWAINS MATE-AIRCRAFT HANDLING	2	54,016	3.7	2.0	1.0	0.1	3.7
6800	AE	AVIATION ELECTRICIANS MATE	3	167,461	1.8	6.4	0.5	0.1	1.4
6900	AM	AVIATION STRUCTURAL MECHANIC	0	13,761	0.0	0.7	0.0	0.0	-
6901	A8	AVIATION STRUCTURAL MECHANIC-STRUCTURES	7	151,782	4.6	5.6	1.2	0.5	2.6
6902	A7	AVIATION STRUCTURAL MECHANIC-HYDRAULICS	5	99,015	5.1	3.7	1.4	0.4	3.2
6903	A6	AVIATION STRUCTURAL MECHANIC-SAFETY EQUIPMENT	3	54,288	5.5	2.0	1.5	0.3	4.4
7000	PR	AIRCREW SURVIVAL EQUIPTMAN	1	44,508	2.3	1.7	0.6	0.0	3.3
7100	AG	AEROGRAPHERS MATE	0	30,748	0.0	1.2	0.0	0.0	-
7200	TD	TRADEVMAN	0	16,499	0.0	0.7	0.0	0.0	-
7300	AK	AVIATION STOREKEEPER	2	63,523	3.2	2.5	0.8	0.1	2.9
7400	AZ	AVIATION MAINTENANCE ADMINISTRATIONMAN	1	58,371	1.7	2.3	0.4	0.0	2.4
7500	AS	AVIATION SUPPORT EQUIPMENT TECHNICIAN	1	27,911	3.6	1.2	0.8	0.0	4.6
7501	A9	AVIATION SUPPORT EQUIPMENT TECHNICIAN-ELECTRICAL	0	6,660	0.0	0.2	0.0	0.0	-
7502	AH	AVIATION SUPPORT EQUIPMENT TECHNICIAN-HYDRAULICS/STRUCTURES	0	2,743	0.0	0.1	0.0	0.0	-
7503	AA	AVIATION SUPPORT EQUIPMENT TECHNICIAN-MECHANICAL	0	11,881	0.0	0.4	0.0	0.0	-
7600	PH	PHOTOGRAPHERS MATE	2	33,676	5.9	1.3	1.6	0.2	5.6
7800	AR	AIRMAN RECRUIT	4	338,083	1.2	7.4	0.5	0.2	1.4
8000	HM	HOSPITAL CORPSMAN	21	414,819	5.1	15.4	1.4	0.8	2.1
8300	DT	DENTAL TECHNICIAN (GENERAL/PROSTHODONTICS/REPAIR)	3	31,547	9.5	1.2	2.6	0.5	7.6
8700	DT	DENTAL TECHNICIAN (EFFECTIVE MARCH, 1995)	1	7,088	14.1	0.3	3.6	0.1	20.2
TOTAL			296	8,710,856	3.3	304.4	1.0	0.9	1.1

SIRs were computed using the age-specific incidence (first hospitalization) rates for sarcoidosis in the white male enlisted Navy population for the period from 1 January 1975 to 30 June 2001 as the standard.
All occupations are shown, including any which had no cases during 1975-2001. Ninety five percent confidence intervals are based on the Poisson distribution (26).

Table 15. Sarcoidosis (ICD9 Code 135) incidence (first hospitalization) rates per 100,000 person-years and standardized incidence ratios by occupation, Navy enlisted black men, 1 January 1975 - 30 June 2001*

Occupation	Code	Description	No. of Observed Cases	No. of Person-Years	Incidence Rate	No. of Expected Cases	Standardized Incidence Ratio	95% Confidence Interval	
								Lower	Upper
0100	BM	BOATSWAINS MATE	10	84,188	11.9	24.2	0.4	0.2	0.8
0150	MA	MASTER-AT-ARMS	0	4,278	0.0	1.2	0.0	0.0	-
0200	QM	QUARTERMASTER	1	13,055	7.7	3.4	0.3	0.0	1.6
0250	SM	SIGNALMAN	2	14,655	13.6	3.8	0.5	0.1	1.9
0300	OS	OPERATIONS SPECIALIST	14	44,019	31.8	11.2	1.2	0.7	2.1
0350	EW	ELECTRONICS WARFARE TECHNICIAN	0	4,745	0.0	1.2	0.0	0.0	-
0400	ST	SONAR TECHNICIAN	0	575	0.0	0.2	0.0	0.0	-
0401	SG	SONAR TECHNICIAN-SURFACE	1	9,200	10.9	2.4	0.4	0.0	2.4
0404	SS	SONAR TECHNICIAN-SUBMARINE	0	4,132	0.0	1.1	0.0	0.0	-
0450	OT	OCEAN SYSTEMS TECHNICIAN	1	585	170.9	0.2	6.8	0.2	37.9
0451	OT	OCEAN SYSTEMS TECHNICIAN, ANALYST	1	866	115.5	0.2	4.6	0.1	25.4
0452	OT	OCEAN SYSTEMS TECHNICIAN, MAINTENANCE	0	155	0.0	0.0	0.0	0.0	-
0500	TM	TORPEDOMANS MATE (SUB-SURFACE/SURFACE)	5	13,603	36.8	3.5	1.4	0.5	3.3
0600	GM	GUNNERS MATE	0	3,981	0.0	1.0	0.0	0.0	-
0601	GI	GUNNERS MATE-MISSILES	0	4,641	0.0	1.2	0.0	0.0	-
0602	GT	GUNNERS MATE-TECHNICIAN	2	2,112	94.7	0.5	3.7	0.4	13.3
0604	GG	GUNNERS MATE-GUNS	2	11,196	17.9	3.0	0.7	0.1	2.4
0700	FC	FIRE CONTROLMAN	2	9,923	20.2	2.6	0.8	0.1	2.8
0800	FT	FIRE CONTROL TECHNICIAN	0	951	0.0	0.3	0.0	0.0	-
0801	FG	FIRE CONTROL TECHNICIAN-GUN	2	2,479	80.7	0.7	3.1	0.4	11.1
0802	FM	FIRE CONTROL TECHNICIAN-SURFACE MISSILE	1	1,752	57.1	0.5	2.2	0.1	12.2
0803	FB	FIRE CONTROL TECHNICIAN-BALLISTIC MISSILE	0	701	0.0	0.2	0.0	0.0	-
0810	MT	MISSILE TECHNICIAN	0	2,030	0.0	0.5	0.0	0.0	-
0900	MN	MINEMAN	0	857	0.0	0.2	0.0	0.0	-
1000	ET	ELECTRONICS TECHNICIAN	5	23,722	21.1	6.3	0.8	0.3	1.9
1001	E1	ELECTRONICS TECHNICIAN-COMMUNICATIONS	0	886	0.0	0.2	0.0	0.0	-
1002	E2	ELECTRONICS TECHNICIAN-RADAR	0	697	0.0	0.2	0.0	0.0	-
1010	DS	DATA SYSTEMS TECHNICIAN	0	3,682	0.0	1.0	0.0	0.0	-
1080	PI	PRECISION INSTRUMENTMAN	0	31	0.0	0.0	0.0	0.0	-
1100	IM	INSTRUMENTMAN	1	1,021	97.9	0.3	3.7	0.1	20.6
1200	OM	OPTICALMAN	1	739	135.3	0.2	5.3	0.1	29.4
1400	NC	NAVY COUNSELOR	0	7,263	0.0	1.8	0.0	0.0	-
1500	RM	RADIOMAN CHANGE TO (IT)	15	79,414	18.9	20.4	0.7	0.4	1.2
1600	C2	CTR/CTT COMBINATION	0	154	0.0	0.1	0.0	0.0	-
1611	CT	CRYPTOLOGIC TECH-TECHNICAL	1	4,690	21.3	1.2	0.8	0.0	4.6
1622	CA	CRYPTOLOGIC TECH-ADMINISTRATIVE	1	3,503	28.5	0.9	1.1	0.0	6.1
1633	C1	CRYPTOLOGIC TECH-MAINTENANCE	0	2,623	0.0	0.7	0.0	0.0	-

1644	CO	CRYPTOLOGIC TECH-COMMUNICATIONS	1	3,978	25.1	1.0	1.0	0.0	5.5
1655	CR	CRYPTOLOGIC TECH-COLLECTION	1	7,094	14.1	1.9	0.5	0.0	3.0
1666	CI	CRYPTOLOGIC TECH-INTERPRETIVE	0	954	0.0	0.3	0.0	0.0	-
1700	YN	YEOMAN	17	59,049	28.8	15.4	1.1	0.6	1.8
1750	LN	LEGALMAN	0	1,959	0.0	0.6	0.0	0.0	-
1800	PN	PERSONNELMAN	2	20,351	9.8	5.4	0.4	0.0	1.3
1900	DP	DATA PROCESSING TECHNICIAN CHANGED TO (IT)	1	7,954	12.6	2.1	0.5	0.0	2.6
2000	SK	STOREKEEPER	14	41,870	33.4	11.1	1.3	0.7	2.1
2100	DK	DISBURSING CLERK	4	10,551	37.9	2.8	1.4	0.4	3.7
2200	MS	MESS MANAGEMENT SPECIALIST	18	78,760	22.9	20.4	0.9	0.5	1.4
2300	IS	INTELLIGENCE SPECIALIST	0	3,021	0.0	0.8	0.0	0.0	-
2490	SH	SHIPS SERVICEMAN	23	37,779	60.9	9.8	2.3	1.5	3.5
2500	RP	RELIGIOUS PROGRAMS SPECIALIST	2	3,275	61.1	0.9	2.3	0.3	8.3
2600	JO	JOURNALIST	2	1,238	161.6	0.3	6.0	0.7	21.5
2700	PC	POSTAL CLERK	2	7,290	27.4	1.9	1.0	0.1	3.7
3100	LI	LITHOGRAPHER	0	2,266	0.0	0.6	0.0	0.0	-
3200	DM	ILLUSTRATOR DRAFTSMAN	1	1,202	83.2	0.3	3.1	0.1	17.0
3300	MU	MUSICIAN	0	1,276	0.0	0.4	0.0	0.0	-
3600	SR	SEAMAN RECRUIT	42	201,378	20.9	42.1	1.0	0.7	1.3
3700	MM	MACHINISTS MATE	15	53,651	28.0	13.9	1.1	0.6	1.8
3800	EN	ENGINEMAN	5	27,800	18.0	7.3	0.7	0.2	1.6
3900	MR	MACHINERY REPAIRMAN	1	3,887	25.7	1.0	1.0	0.0	5.4
4000	BT	BOILER TECHNICIAN-AT E6, MAY OPT FOR BR	7	25,193	27.8	6.5	1.1	0.4	2.2
4020	BR	BOILERMAKER	0	1,575	0.0	0.4	0.0	0.0	-
4100	EM	ELECTRICIANS MATE	7	31,258	22.4	8.1	0.9	0.3	1.8
4200	IC	INTERIOR COMMUNICATIONS ELECTRICIAN	5	19,480	25.7	5.1	1.0	0.3	2.3
4300	HT	HULL MAINTENANCE TECHNICIAN	6	19,168	31.3	5.1	1.2	0.4	2.6
4400	GS	GAS TURBINE SYSTEM TECHNICIAN	0	275	0.0	0.1	0.0	0.0	-
4401	G2	GAS TURBINE SYSTEM TECHNICIAN - ELECTRICAL	0	3,111	0.0	0.8	0.0	0.0	-
4402	G3	GAS TURBINE SYSTEM TECHNICIAN - MECHANICAL	0	6,180	0.0	1.6	0.0	0.0	-
4500	DC	DAMAGE CONTROLMAN	2	7,935	25.2	2.1	0.9	0.1	3.4
4600	PM	PATTERNMAKER	0	267	0.0	0.1	0.0	0.0	-
4700	ML	MOLDER	0	313	0.0	0.1	0.0	0.0	-
5000	FR	FIREMAN RECRUIT	12	63,875	18.8	13.4	0.9	0.5	1.6
5080	CU	CONSTRUCTIONMAN	0	43	0.0	0.0	0.0	0.0	-
5100	EA	ENGINEERING AID	0	385	0.0	0.1	0.0	0.0	-
5300	CE	CONSTRUCTION ELECTRICIAN	1	4,071	24.6	1.1	0.9	0.0	5.3
5380	EQ	EQUIPMENTMAN	0	133	0.0	0.0	0.0	0.0	-
5410	EO	EQUIPMENT OPERATOR	1	3,226	31.0	0.8	1.2	0.0	6.7
5500	CM	CONSTRUCTION MECHANIC	1	2,820	35.5	0.8	1.3	0.0	7.5
5600	BU	BUILDER	0	4,144	0.0	1.1	0.0	0.0	-
5700	SW	STEELWORKER	0	1,543	0.0	0.4	0.0	0.0	-
5800	UT	UTILITIES MAN	0	2,692	0.0	0.7	0.0	0.0	-

6000	CN	CONSTRUCTIONMAN	1	865	115.6	0.2	5.4	0.1	30.1
6080	AF	AIRCRAFT MAINTENANCE TECHNICIAN	0	510	0.0	0.1	0.0	0.0	-
6180	AV	AVIONICS TECHNICIAN	0	261	0.0	0.1	0.0	0.0	-
6200	AD	AVIATION MACHINISTS MATE	4	34,873	11.5	9.0	0.4	0.1	1.1
6205	A5	AVIATION MACHINISTS MATE-RECIPROCATING ENGINES	0	329	0.0	0.1	0.0	0.0	-
6206	A4	AVIATION MACHINISTS MATE-JET ENGINES	0	1,464	0.0	0.4	0.0	0.0	-
6300	AT	AVIATION ELECTRONICS TECHNICIAN	3	17,700	16.9	4.6	0.7	0.1	1.9
6310	AX	ANTISUBMARINE WARFARE TECHNICIAN	0	1,195	0.0	0.3	0.0	0.0	-
6400	AW	AVIATION ASW OPERATOR (ACOUSTIC/NON-ACOUSTIC)	1	2,050	48.8	0.5	1.9	0.0	10.6
6500	AO	AVIATION ORDNANCEMAN	10	30,830	32.4	7.9	1.3	0.6	2.3
6520	AQ	AVIATION FIRE CONTROL TECHNICIAN	2	2,355	84.9	0.6	3.2	0.4	11.5
6600	AC	AIR TRAFFIC CONTROLLER	1	6,837	14.6	1.8	0.6	0.0	3.2
6700	AB	AVIATION BOATSWAINS MATE	0	334	0.0	0.1	0.0	0.0	-
6704	A1	AVIATION BOATSWAINS MATE-LAUNCH/RECOVERY EQUIPMENT	4	12,846	31.1	3.3	1.2	0.3	3.1
6705	A3	AVIATION BOATSWAINS MATE-FUELS	1	10,619	9.4	2.8	0.4	0.0	2.0
6706	A2	AVIATION BOATSWAINS MATE-AIRCRAFT HANDLING	1	18,449	5.4	4.9	0.2	0.0	1.1
6800	AE	AVIATION ELECTRICIANS MATE	4	24,164	16.6	6.3	0.6	0.2	1.6
6900	AM	AVIATION STRUCTURAL MECHANIC	1	1,362	73.4	0.3	3.0	0.1	16.8
6901	A8	AVIATION STRUCTURAL MECHANIC-STRUCTURES	12	21,413	56.0	5.6	2.1	1.1	3.7
6902	A7	AVIATION STRUCTURAL MECHANIC-HYDRAULICS	5	13,826	36.2	3.6	1.4	0.4	3.2
6903	A6	AVIATION STRUCTURAL MECHANIC-SAFETY EQUIPMENT	3	6,184	48.5	1.6	1.9	0.4	5.5
7000	PR	AIRCREW SURVIVAL EQUIPTMAN	1	2,670	37.5	0.7	1.4	0.0	8.0
7100	AG	AEROGRAPHERS MATE	0	2,481	0.0	0.6	0.0	0.0	-
7200	TD	TRADEVMAN	1	699	143.1	0.2	5.2	0.1	29.0
7300	AK	AVIATION STOREKEEPER	7	19,883	35.2	5.3	1.3	0.5	2.7
7400	AZ	AVIATION MAINTENANCE ADMINISTRATIONMAN	7	16,565	42.3	4.4	1.6	0.6	3.3
7500	AS	AVIATION SUPPORT EQUIPMENT TECHNICIAN	0	5,374	0.0	1.4	0.0	0.0	-
7501	A9	AVIATION SUPPORT EQUIPMENT TECHNICIAN-ELECTRICAL	0	777	0.0	0.2	0.0	0.0	-
7502	AH	AVIATION SUPPORT EQUIPMENT TECHNICIAN-HYDRAULICS/STRUCTURES	0	144	0.0	0.0	0.0	0.0	-
7503	AA	AVIATION SUPPORT EQUIPMENT TECHNICIAN-MECHANICAL	1	998	100.2	0.3	3.8	0.1	20.9
7600	PH	PHOTOGRAPHERS MATE	0	2,949	0.0	0.8	0.0	0.0	-
7800	AR	AIRMAN RECRUIT	14	74,721	18.7	15.7	0.9	0.5	1.5
8000	HM	HOSPITAL CORPSMAN	23	83,529	27.5	21.3	1.1	0.7	1.6
8300	DT	DENTAL TECHNICIAN (GENERAL/PROSTHODONTICS/REPAIR)	7	12,739	54.9	3.2	2.2	0.9	4.5
8700	DT	DENTAL TECHNICIAN (EFFECTIVE MARCH, 1995)	3	5,257	57.1	1.4	2.2	0.5	6.4
TOTAL			378	1,574,626	24.0	394.3	1.0	0.9	1.1

SIRs were computed using the age-specific incidence (first hospitalization) rates for sarcoidosis in the total male enlisted Navy population for the period from 1 January 1975 to 30 June 2001 as the standard.
All occupations are shown, including any which had no cases during 1975-2001. Ninety five percent confidence intervals are based on the Poisson distribution (26).

Shipboard Duty-Station Assignments and Incidence of Sarcoidosis in Navy Personnel: A Nested Case-Control Study, 1965-2001

Edward D. Gorham, M.P.H., Ph.D.[1]; Cedric F. Garland, Dr. P.H.[1,2]; Frank C. Garland, Ph.D.[1]; CAPT Richard Thomas[3]; Kevin Kaiser, M.P.H.[4]; William D. Travis, M.D.[5], Jose A. Centeno, Ph.D. [5]

[1]Naval Health Research Center, San Diego, CA

[2]Department of Family and Preventive Medicine, University of California, San Diego, La Jolla, CA

[3]Navy Environmental Health Center, Norfolk VA

[4]GEO-CENTERS, INC., Clinton, MD

[5]Armed Forces Institute of Pathology, Washington, DC

Report Number 02-34 was supported by the Navy Bureau of Medicine and Surgery, under work unit 60208. The views expressed in this report are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or U.S. Government. Approved for public release; distribution unlimited. This research has been conducted in compliance with all applicable Federal Regulations governing the protection of human subjects in research.

Running title: Sarcoidosis in Navy Personnel

Corresponding author: Edward D. Gorham, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92186-5122. Telephone (619) 524-9876; fax (619) 524-9888; e-mail: gorham@nhrc.navy.mil

Word count: abstract 232; remaining text 4,169.

Acknowledgments

The authors are grateful for the thoughtful contributions and helpful guidance and information provided by the following individuals: Gary Hunninghake, M.D., Chairman, Navy Lung Disease Assessment Program Scientific Advisory Council, Sarcoidosis Research Institute and Professor, Pulmonary Division, University of Iowa College of Medicine; Victor Roggli, M.D., Chairman, Surgical Case Review Committee, Durham NC Veterans Administration Medical Center and Professor, Department of Pathology, Duke University School of Medicine; Mr. Jerry Cochran, Pastor, and Director, Jerry Cochran Veterans Outreach Foundation; Magdi Soliman, Ph.D., Professor of Pharmacology and Toxicology Program, Director, Environmental Health and Toxicology Research Program, Florida A&M University; Jerrold L. Abraham, M.D., Director, Pathology Core Laboratory for the New York Occupational Health Clinics Network and Professor of Pathology, State University of New York at Syracuse NY; Elaine B. Panitz, M.D., M.P.H., Clinical Assistant Professor, Department of Medicine, Robert Wood Johnson Medical School, Piscataway, NJ; CAPT Garry Rudolph, Navy Bureau of Medicine and Surgery, Washington, DC; Dr. Florabel Mullick, Principal Deputy Director, Armed Forces Institute of Pathology, Washington, DC; CAPT David Trump, Uniformed Services University of the Health Sciences, Bethesda, MD; and Dr. Han Kang, Veterans Administration, Washington, DC. The authors express thanks to Milan Miller for data from the Career History Archival Medical and Personnel System at the Naval Health Research Center, San Diego, CA, and CAPT Ken Capps from the Department of Clinical Investigations, Walter Reed Army Medical Center, Washington, D.C. for his scientific-chemical review of case materials. We also express our gratitude to Mike Dove and Scott Segar of the Defense Manpower Data Center, Monterey, CA, and Mariam Serra from the Department of Environmental and Toxicologic Pathology, AFIP, for their valuable technical assistance and provision of data and to Ms. Michele Cambou at the Naval Health Research Center for her superlative contributions and skills in data analysis.

List of Acronyms

Acronyms	Definition
AFIP	Armed Forces Institute of Pathology
CHAMPS	Career History Archival Medical and Personnel System
CI	Confidence Interval
CV	Aircraft carrier, multi-purpose
CVA	Aircraft carrier, attack
CVAN	Aircraft carrier, attack, nuclear propulsion
CVN	Aircraft carrier, nuclear propulsion, multi-purpose
CVS	Aircraft carrier, anti-submarine warfare
DEERS	Defense Enrollment Eligibility Reporting System
DMDC	Defense Manpower Data Center
EI/DS	Executive Information/Data System
ICD-9	International Classification of Diseases, Ninth Revision
OBAC	On Board Activity Code (for shipboard duty stations)
OR	Odds Ratio
PAMI	Personnel Accounting Machine Identification (code for duty stations)
PNEC	Primary Naval Enlistment Classification
SIDR	Standard Inpatient Data Record
SIR	Standardized Incidence Ratio
SSN	Social Security Number
UIC	Unit Identification Code

Abstract

The Navy Bureau of Medicine and Surgery requested establishment of an occupational lung disease assessment program to examine the extent to which lung diseases, especially sarcoidosis, may have been misdiagnosed among Navy personnel, and to evaluate the relationship between sarcoidosis with occupation and service aboard Navy ships. This case-control study identified N= 1,162 Navy enlisted men with a hospital discharge diagnosis of sarcoidosis while serving on active-duty during 1965 to 2001. A control population consisting of a 2 % random sample (N = 109,037) of Navy enlisted men serving on active duty during this time-period was also identified. Risk of sarcoidosis hospitalization according to duty station assignment and occupation was examined using a logistic regression model that controlled for age, race, date of entry to naval service, history of assignment aboard an aircraft carrier, home of record, and other characteristics. Time trends in sarcoidosis risk were examined by stratification according to accession periods in cases and controls. Time-dependence of risk was also analyzed using indicator variables corresponding to period of entry to naval service in the logistic regression model. Statistically significant univariate differences between cases and controls were apparent for a variety of service-related and demographic characteristics including: age, length of service, race, pay grade, history of service aboard an aircraft carrier, most recent occupation, and home of record. The association with history of service aboard an aircraft carrier persisted after multiple adjustment.

Introduction

Although the etiology of sarcoidosis remains to be discovered, some previous studies have suggested the possibility of an occupational component in sarcoidosis risk (1-7). Sarcoidosis is a granulomatous disease with highly variable symptoms that may involve any organ system (8,9), although lung involvement is present in over 90% of cases (10). Presenting signs of lung abnormalities found on chest radiograph include thoracic mediastinal widening, diffuse pulmonary and nodular infiltration, and bilateral hilar lymphadenopathy (9,10). Common respiratory symptoms such as cough and shortness of breath may accompany initial presentation (11-13). As many as one half of patients may be asymptomatic and historically have often been discovered incidentally as a result of a routine chest radiograph (10-12). In some patients, sarcoidosis appears for a period of 2 to 3 years and resolves, but 10% to 15% of patients may be chronically affected (12-14). Many cases are believed to resolve before they are recognized (11,12), but progression to fibrotic lung disease may occur. Some permanent lung damage occurs in approximately 20% of pulmonary cases, and the disease is fatal in 5% to 10% of cases where either the granulomas or fibrosis seriously affect the function of a vital organ (14).

The epidemiology of sarcoidosis was reviewed in a Statement on Sarcoidosis by the American Thoracic Society (15). Although a variety of environmental, occupational, infectious, and genetic risk factors have been suggested since the disorder was first documented in Europe 100 years ago, no single exposure has been found that accounts for the distribution of sarcoidosis (15,16). Sarcoidosis occurs in both sexes, all age groups, and all races (17-21). In the United States, sarcoidosis is diagnosed most commonly among 20- to 40-year-old adults, with a peak at ages 20-29 years (15). Prevalence is higher among blacks than whites, approaching 40 per 100,000 in blacks compared with 5 per 100,000 in whites (15,19). The incidence rate of sarcoidosis in whites in a population-based study in Rochester, Minnesota, was 6 per 100,000 person-years, with little sex difference (19). Individuals of Puerto Rican, Scandinavian, German, or Irish origin are reported to be at greater than average risk (16). Sarcoidosis was once thought to be rare in North America, but a large number of cases were identified in the military beginning in the mid-1940s during annual chest radiographic screening in the armed forces (22), a practice that has been greatly reduced since the mid-1970s. The systematic medical surveillance of military personnel that, until recently, included routine chest radiographs has led to several

studies of sarcoidosis in military populations (7,22-24). These and other epidemiological studies have identified higher risk for sarcoidosis in residents of the Southeast and rural areas of the United States, but few other risk factors have been identified (25-29). Due to the variability of symptoms and population groups in which sarcoidosis can occur, diagnosis may be difficult and involves ruling out alternative diseases with similar signs or symptoms (15).

Metal particles have been identified in pulmonary (30-32) or cutaneous (33,34) granulomatous diseases, including particles of titanium (30), aluminum (31,32), an aluminum-zirconium complex (33), and various foreign bodies (34). Although the identification of foreign bodies in granulomas was historically thought to exclude a diagnosis of sarcoidosis, recent investigation using electron probe microanalysis found polarizable foreign bodies consisting of calcium, phosphorus, silicon, or aluminum in granulomatous skin lesions in some patients with cutaneous sarcoidosis (34). The authors suggested that the foreign body may have served as an inciting stimulus for granuloma formation in some cases of sarcoidosis (35).

Silica-induced granulomas of the lung have been reported in individuals exposed to glass fibers or rock wool that are composed of silicates (36). One small case-control study found an odds ratio of 13.2 (95% CI, 2.0 to 140.9) in individuals who were occupationally or environmentally exposed to crystalline silica (cristobalite) from a plant that processed diatomaceous earth (36). A study conducted by the National Institute for Occupational Safety and Health suggested a possible relationship of sarcoidosis with assignment aboard aircraft carriers and with removal of non-skid material (5). Non-skid coatings have been used extensively on Navy ship decks and ramps. Particulate matter consisting of silica, silicates, fibrous glass, talc, iron, barium sulfate, aluminum, and titanium have been identified in two samples of nonskid material (37). Among numerous occupational groups, Navy boatswain's mates assigned to aircraft carriers may have had the greatest opportunities for exposure to nonskid coatings. It is unknown to what degree this group is at risk for occupational lung disease and whether members of this group may be more likely to have a sarcoidosis diagnosis than other occupational groups. At the request of the U.S. Congress, the Secretary of the Navy, the Secretary of Veterans Affairs, and the Director of the Armed Forces Institute of Pathology, were directed to establish a Navy occupational lung disease assessment program. The program's goal was to determine if naval personnel with lung disease due to other causes may have been misdiagnosed with sarcoidosis, and if the incidence of sarcoidosis or other lung diseases could be

attributable to service aboard Navy ships. The Naval Health Research Center, San Diego, was designated by the Navy Bureau of Medicine and Surgery to manage the Navy Lung Disease Assessment Program.

Objectives

The objectives of this case-control study are to examine risk of sarcoidosis hospitalization according to a combination of history of duty-station assignment aboard an aircraft carrier and assignment to specific Navy enlisted occupations previously identified as being of interest. The analysis was designed to control for age, race, year of entry into naval service, history of assignment aboard an aircraft carrier, and home of record. This study also had the objective of examining time-trends in risk of a diagnosis of sarcoidosis in active-duty Navy enlisted men according to Navy occupational specialty and duty station assignment and to assess any time-dependent features in risk.

Because sarcoidosis is a disease of.unknown cause, some indication of the extent to which pneumoconioses, and other lung diseases related to dust exposure may have been misdiagnosed among Navy enlisted men as sarcoidosis could be inferred by discovery of an historical association between sarcoidosis risk and duty station assignment or service in particular Navy enlisted occupational groups with likely exposures to metallic, silicaceous, or other inorganic dust particles.

Methods

This study used a case-control design. Cases were identified among Navy enlisted men serving on active duty between 1965 and 2001. Incident hospitalized cases of sarcoidosis were identified using the Standard Inpatient Data Record database of admissions to Department of Defense medical treatment facilities in recent years (1989-2001) and other Navy data sources from 1965 to 1988. Records of men with a hospital discharge diagnosis of sarcoidosis in any position in the hospital discharge summary (positions 1 to 8) were identified. The standard inpatient data records identify diagnoses in the *International Classification of Diseases, 9th edition, Clinical Modification* (ICD-9-CM) format (38). Earlier Navy inpatient data records

captured discharge diagnoses for sarcoidosis using Department of Defense Disease Identification Codes from 1965 to 1969, ICDA-8 codes from 1978 to 1979, ICD-9 codes from 1980 to 1984, and ICD-9-CM codes from 1985 to 1988.

Demographic and other personnel information from other established military data sources were used to supplement Standard Inpatient Data Record and validate personnel and demographic information. The main source for validation of career and demographic information among active-duty military personnel in this study was the Defense Enrollment Eligibility Reporting System, which is the central source for personnel information for the Department of Defense. This database is used to determine medical benefits eligibility, insurance, immunizations, and patient demographic information. Records were merged into the Career History Archival Medical and Personnel System database created and maintained by the Naval Health Research Center. Occupations were identified using Navy enlisted Manpower and Personnel Classification codes.

A control population consisting of a 2% random sample (N = 109,037) of active-duty Navy enlisted men serving during this time-period was also identified. Controls were selected for each of the 37 years of the study period using a 2% probability selection procedure based on a random selection process using the last two digits of the social security number.

Fixed-length file records for cases and controls were constructed in identical formats using extracts from the Career History Archival Medical and Personnel System (CHAMPS)(39). The record allowed coding of up to 30 duty station assignments throughout an individual's career history based on Unit Identification Code and Onboard Activity Code changes. The file also identified the enlisted occupational code (rate) at the time of each duty station change. Among the controls, the median number of duty station assignments was 6. Age of the cases was calculated using the difference between the first hospitalization date for sarcoidosis and the birth date. Age of the controls was calculated using the difference between date of the sixth duty station assignment and the birth date. If no sixth duty station was assigned, the date of the fifth duty station assignment was used as a basis for the age calculation. This process was repeated until age could be calculated for all controls including those with even a single duty station assignment. Important demographic and service-related variables of interest for obtained for cases and controls are summarized in Table 1.

Table 1. Demographic and Service-Related Information Obtained

Social Security Number or service identification number

Name

Date of birth

Race (white, black, other)

Gender

Home of record

Date of accession to naval service

Duty station assignments and dates (Unit Identification Code, Onboard Activity Code)

Occupational history (Navy rate code)

Date of end of naval service

Type of discharge (loss code)

If a case:

- Diagnosis
- Date of first hospitalization with a diagnosis of sarcoidosis
- Name of Medical Treatment Facility (hospital)

Odds ratios (ORs) for sarcoidosis hospitalization according to duty station assignment and occupation were examined using a logistic regression model that controlled for age, race, year of entry into naval service, history of assignment aboard an aircraft carrier, and home of record. Time trends in sarcoidosis risk were examined by stratification according to period of accession to Navy service in cases and controls. Time-dependence of risk was also analyzed by using indicator variables corresponding to accession periods.

Results

Results

Univariate Findings

A summary of the characteristics of the cases and controls according to demographic and service related information is shown in Table 2. Statistically significant univariate differences between cases and controls were apparent for a variety of service-related and demographic characteristics including: age, length of service, race, pay grade, history of service aboard an aircraft carrier, date of Navy entrance, age at entrance into the Navy, and regional home of record. Sarcoidosis cases were on the average about 2 years older than controls, which was a statistically significant difference. Approximately half the cases were black compared with 11 % of the controls.

Length of service of 4 to 5.9 years was associated with decreased risk while service of greater than 6 years was associated with increased risk. Nearly 45% of the cases had six or more years of naval service compared with 27% of the controls. Sarcoidosis cases also tended to be in higher enlisted pay grades (E6 and higher) than controls. The univariate odds ratio for history of assignment to an aircraft carrier was about 2, suggesting that cases were about twice as likely as controls to have been assigned to an aircraft carrier.

The annual number of sarcoidosis cases has declined in recent years. The odds ratios for accession periods from 1987 through 2001 were less than 1.0, in comparison with odds ratios for accession periods prior to 1982, which were greater than 1.0.

Sarcoidosis cases were more likely than the controls to have entered the Navy slightly later in life, with more having entered at ages 20 to 24, 25 to 29, and 30 to 34 years, compared with the controls. Cases were about 3 times as likely to live (have their home of record) in the southeastern United States than in other regions. The odds ratios by home region were particularly low for those whose homes were in the Pacific (odds ratio, 0.45, 95% CI, 0.35 to 0.57) or Mountain (odds ratio, 0.33, 95% CI, 0.19 to 0.53) regions.

Characteristics of white cases and controls are summarized in Table 3 and were similar to those of all active-duty men. White cases were on average about 2 years older than their controls. An association with length of service greater than 6 years was present in whites as was an association with higher pay grade. White cases were about 1.6 times as likely as the controls to have served aboard an aircraft carrier. Only about 1% of the white cases joined the Navy after 1993 compared with 8% of their race-matched controls. White cases were twice as likely to

have their home of record in the southeastern United States than in other regions. The odds ratio associated with home in the Pacific or Mountain region was significantly low.

Characteristics of black cases and controls are summarized in Table 4. The black cases were on the average about one year older than the black controls, and tended to have longer length of service than the controls, with a statistically significantly elevated odds ratio associated with length of service of 6 or more years. Most cases were in higher pay grades than the controls. Black cases were about twice as likely as black controls to have served aboard an aircraft carrier, slightly higher than the odds ratio associated with carrier service history for white men. Only about 1% of the black cases joined the Navy in 1994 or later, compared with 15% of their controls, which was similar to the pattern in white men. Black cases were twice as likely to have their home of record in the southeastern U.S. than in other regions, as in white men. The odds ratio associated with home in the Pacific region was low.

Stratified Findings

Duty Station and Occupation. Risk of sarcoidosis first hospitalization according to duty station assignment and occupation were examined using odds ratios stratified by history of aircraft carrier assignment and race. Odds ratios according to occupation were calculated separately for white and black men who had a history of assignment aboard an aircraft carrier at any time in their naval career and for those who had no known history of assignment to a carrier (Tables 5 and 6).

In white men who ever were assigned aboard an aircraft carrier, the lower limit of the 95% confidence interval of the odds ratio exceeded 1.0 for ratings of Aircraft Maintenance Technician (odds ratio, 54.6), Aviation Machinist's Mate (odds ratio, 6.9), Aviation Structural Mechanic–Structures (odds ratio, 5.0), Air Traffic Controller (odds ratio, 3.6), Aviation Support Electronics Technician (odds ratio, 3.3), and Electrician's Mate (odds ratio, 2.9).

In white men who never were assigned aboard an aircraft carrier, the lower limit of the 95% confidence interval of the odds ratio exceeded 1.0 for ratings of Gas Turbine System Technician (odds ratio, 26.0), Aircraft Maintenance Technician (odds ratio, 8.4), Aviation Structural Mechanic (odds ratio, 3.0), Hospital man (odds ratio, 3.0), Machinist's mate (odds ratio, 2.2), Other aviation occupations (odds ratio, 2.2), Aviation Electrician (odds ratio, 2.0), and Mess Management Specialist (odds ratio, 1.8) (Table 5). The rating of Aircraft Maintenance

Technician was associated with a statistically significantly elevated risk in white men with or without a history of aircraft carrier service (odds ratios, 54.6 and 8.4, respectively).

Among black men with a history of assignment aboard an aircraft carrier (Table 6), the lower 95% confidence limit was greater than 1.0 for ratings of Aviation Structural Mechanic specializing in structures (odds ratio, 7.8), Ship's Serviceman (odds ratio, 2.8), and Hospital man (odds ratio, 2.4).

Among black enlisted personnel with no history of service aboard aircraft carriers, statistically significantly elevated odds ratios were observed for Fire Control Technician (odds ratio, 12.0), Aviation Structural Mechanic-Unspecified (odds ratio, 7.0) Aviation Structural Mechanic-Structures (odds ratio, 4.0), Disbursing Clerk (odds ratio, 2.9), Boiler Technician (odds ratio, 2.4), Hospital man (odds ratio, 2.4), Other aviation occupations (odds ratio, 1.8), Machinist's Mate (odds ratio, 1.8), and Ship's Serviceman (odds ratio, 3.1). Three ratings, Aviation Structural Mechanic-Structures, Hospital man, and Ship's Serviceman, had statistically significantly high odds ratios in both aircraft carrier assignment groups among black men.

Multivariate Logistic Regression Findings

Based on previous research, ratings of Airman, Seaman, Fireman, Aviation Boatswain's Mate, other aviation ratings, Mess Management Specialist, and Ship's Serviceman were included in the regression model. All remaining ratings were used as the reference group

Multiple-adjusted odds ratios for sarcoidosis adjusted by logistic regression for age, race, date of entry to the Navy, rating, history of service aboard an aircraft carrier, and home of record are shown in Table 7. Odds ratios were markedly lower in men 17 to 19 and 20 to 24 years of age than in men 25 years and older. The odds ratio for black men compared with white men was 7.7. Odds ratios were substantially lower for men who entered the Navy after 1975 than those who entered before then. The highest statistically significant odds ratios for occupations were for Seaman (odds ratio, 2.4), followed by Mess Management Specialist, Airman, and Ship's Serviceman. The odds ratio for history of assignment to an aircraft carrier was 1.7 (95% CI, 1.5 to 2.0). Having a home of record in the Southeast was associated with twice the likelihood of sarcoidosis as having a home in the Northeast.

Multiple-adjusted odds ratios for sarcoidosis for white men are shown in Table 8. Odds ratios were lower in those 17 to 19 and 20 to 24 years old than in those 25 years and older, as in men of all races combined. Odds ratios were substantially lower for men who entered the Navy after 1975 than for those who entered before then, and declined steeply during 1975 to 2001. The only statistically significant odds ratios for occupations were for Ship's Serviceman (odds ratio, 2.4), Mess Management Specialist (odds ratio, 2.1) and Airman (odds ratio, 1.8). The odds ratio for history of assignment to an aircraft carrier was 1.49. Having a home of record in the Southeast was associated with twice the likelihood of sarcoidosis as having a home in the Northeast, the same as for the analysis of men of all races.

Multiple-adjusted odds ratios for sarcoidosis for black men are shown in Table 9. Odds ratios were lower in men 17 to 19 and 20 to 24 years old than in those 25 years and older. As for white men, odds ratios were substantially lower in men who entered the Navy after 1975 than those who entered before 1975, and declined steeply during 1975 to 2001. There were statistically significantly high adjusted odds ratios for the occupations of Seaman (odds ratio, 2.6) and Mess Management Specialist (odds ratio, 1.9). The odds ratio for Ship's Serviceman (odds ratio, 1.3) was not statistically significantly high. Having a history of assignment to an aircraft carrier was associated with approximately twice the likelihood of sarcoidosis. Having a home of record in the Southeast also was associated with nearly twice the likelihood of sarcoidosis.

Multiple-adjusted odds ratios are summarized in Table 10 according to period of entry into naval service and race, with details on the types of screening tests for chest disease that were required by the Navy during each period. Odds ratios for sarcoidosis declined as the requirements for screening Navy service members for chest disease were reduced over time.

Discussion

Although its cause is unknown, the epidemiology of sarcoidosis suggests that infectious agents or environmental factors could be important in its etiology (12,14-29). Like respiratory infections, seasonal occurrence of sarcoidosis symptoms has been reported with presentation more common during the winter and early spring (27). Cases have been reported to cluster in specific geographic regions and the disease is found more often in individuals living in rural locations (25,26,28,29,40,41).

Population-based epidemiological studies of sarcoidosis are complicated, however, by the suspected high prevalence of undetected cases and the wide variety of other lung disorders with similar clinical presentations but distinct etiologies. Beryllium disease was recognized as the cause of a cluster of sarcoidosis-like pulmonary disease initially diagnosed among young women employed in a fluorescent light factory in Salem, Massachusetts, in the 1940s (42). More recent studies described pulmonary disease diagnosed as sarcoidosis or a sarcoidosis-like pulmonary disease associated with exposure to silica compounds (35), photocopier toner dust (43), titanium dioxide (44), aluminum dusts (31,32), and zirconium (45).

This study and previous investigations found a substantially higher risk for sarcoidosis among Navy enlisted black men than white men, with a multiple adjusted odds ratio of 7.7 (95% CI, 6.8 to 8.8). The higher prevalence of sarcoidosis among black men remains unexplained but a disproportionate exposure to environmental or infectious agents or a genetic predisposition has been suggested (5,15,22).

Multiple adjusted odds ratios for both black and white men declined notably after 1975 and continued to decline steadily after 1984 and since 1994. In a previous Naval Health Research Center report on sarcoidosis hospitalization among U.S. Navy and Marine Corps personnel during 1981 to 1995, race, age, and enlisted status were significantly associated with a higher risk for sarcoidosis (45). Blacks had 7.5 times the risk of hospitalization for sarcoidosis as whites, and age was positively associated with sarcoidosis risk. Enlisted personnel had approximately twice the risk of hospitalization for sarcoidosis as officers. The highest rates of sarcoidosis admissions occurred between 1981 and 1987 (8.3 per 100,000). Rates appeared to drop dramatically beginning in 1990 and declined to 2.5 per 100,000 in 1995 (46).

The present study provides a further basis to investigate the reasons for the temporal decline in rates in the Navy. Although the decline in sarcoidosis incidence rates in the Navy may reflect unrecognized trends in the general U.S. population, other potential explanations include unknown secular changes in population characteristics that may be associated with risk. Subtle changes in diagnostic criteria over time also may have led to an apparent decline in sarcoidosis incidence observed in this study, if diseases formerly classified as sarcoidosis have been diagnosed as another lung disease in recent years.

Pulmonary sarcoidosis symptoms may mimic symptoms of reactive airways disease (47). It is possible that some of the apparent decline in hospitalized sarcoidosis incidence in the Navy

could be reflected in the increased incidence of asthma or other lung diseases with signs or symptoms similar to sarcoidosis over this time period (48, 49). However, the lack of a contemporaneous increase in incidence of pneumoconioses, asthma, or emphysema and chronic bronchitis in a recent cohort study is evidence against this explanation.

Notably, the decline in sarcoidosis incidence rates parallels a decline in the intensity of surveillance practices in the Navy, specifically the frequency of routine chest radiography (Table 10). Changes in diagnostic and medical screening procedures, particularly a reduction in the frequency of routine chest radiographs for enlisted personnel, could explain some of the secular decline in sarcoidosis incidence. An analysis of time trends in incidence of other chronic lung diseases indicates that the observed decline in sarcoidosis incidence could not be accounted for by increased incidence of other lung diseases with symptoms that may have resembled pulmonary sarcoidosis.

The decline in sarcoidosis incidence also might reflect changes in possibly etiologic work-related exposures. These include changes in formulations of nonskid materials and use of respirators and other measures designed to counteract dust exposure. A previous cohort study identified increased incidence rates of sarcoidosis in black and white Navy enlisted men engaged in certain Navy occupational specialties. In particular, black Ship's Servicemen had 2.3 times the expected incidence of sarcoidosis in comparison with all black Navy enlisted personnel and black Aviation Structural Mechanics specializing in structures had approximately twice the expected incidence. The present study also found occupational associations present among both white and black Navy enlisted personnel. In particular, elevated odds ratios were detected in certain aviation and deck ratings where exposure to non-skid materials may have occurred. Risk was also increased in association with a history of service aboard aircraft carriers. This elevated risk persisted after multiple adjustment and was present in both black and white Navy enlisted men. Navy enlisted men assigned aboard aircraft carriers could be expected to have a higher likelihood and degree of occupational exposure to nonskid material resulting from removal operations than men assigned ashore or to other types of ships.

Duty station and occupational assignment are only rough surrogates for any specific exposures that might be causally related to sarcoidosis or other lung diseases. However, the association of sarcoidosis with assignment to an aviation rating involving duty aboard aircraft carriers found in this and in a previous study (7) suggests two possibilities. The first explanation

is that the diagnosis of a dust-related fibrotic lung disease was erroneously classified as sarcoidosis. This possibility is particularly apparent in black men, for whom a high index of diagnostic suspicion may have led to a differential tendency to classify a pneumoconiosis as sarcoidosis. The other explanation is that a previously unrecognized occupational association exists for sarcoidosis that is associated with service in an aviation rating. This possibility is worthy of further investigation, but would require better characterization of potential occupational exposures and environmental factors common to service in these occupations.

References

1. Parkes SA, Baker SB, Bourdillon RE, Murray CR, Rakshit M, Sarkies JW, Travers JP, Williams EW. Incidence of sarcoidosis in the Isle of Man. Thorax 1985;40:284-287.

2. Bresnitz EA, Stolley PD, Israel HL, Soper K. Possible risk factors for sarcoidosis: a case-control study. Ann NY Acad Sci 1986;465:632-642.

3. Edmonstone WM. Sarcoidosis in nurses: is there an association? Thorax 1988;43:342-343.

4. Kern DG, Neill MA, Wrenn DS, Varone JC. Investigation of a unique time-space cluster in firefighters. Am Rev Respir Dis 1993;148:974-980.

5. Centers for Disease Control. Sarcoidosis among U.S. Navy enlisted men, 1965-1993. MMWR Morb Mortal Wkly Rep. 199713;46:539-43.

6. Prezant DJ, Dhala A, Goldstein A, Janus D, Ortiz F, Aldrich TK, Kelly KJ. The incidence, prevalence, and severity of sarcoidosis in New York City firefighters. Chest. 1999 Nov;116(5):1183-93.

7. Jajosky P. Sarcoidosis diagnoses among US military personnel: trends and ship assignment associations. Am J Prev Med. 1998;14:176-83.

8. Fanburg BL, Lazarus DS. Sarcoidosis. In: Murray JF, Nadel JA, eds. Textbook of Respiratory Medicine, 2nd ed. Philadelphia: Saunders; 1994:1873-88.

9. Keller AZ. Anatomic sites, age attributes, and rates of sarcoidosis in US veterans. Am Rev Respir Dis. 1973;54:87-98.

10. Katz S. Clinical presentation and natural history of sarcoidosis. In: Fanburg BL, ed. Sarcoidosis and Other Granulomatous Diseases of the Lung. New York: Marcel Dekker; 1983:3-36.

11. Travis WD, Colby TV, Koss MN, Rosado-de-Christensen ML, Müller NL, King TE,: Atlas of Nontumor Pathology, Non-neoplastic Disorders of the Lower Respiratory Tract, Armed Forces Institute of Pathology, American Registry of Pathology, Washington DC, 2002.

12. James DG, Turiaf I. Hosoda Y. Description of sarcoidosis: report of the Subcommittee on Classification and Definition. Ann N Y Acad Sci. 1976;278:742.

13. Sharma OP, Bijwadia J. Monitoring and treating sarcoid lung disease. J Respir Dis. 1993;14:750-60.

14. Keller AZ. Hospital, age, racial, occupational, geographical, clinical and survivorship characteristics in the epidemiology of sarcoidosis. Am J Epidemol. 1971;94:222-30.

15. American Thoracic Society. Statement on Sarcoidosis. Am J Respir Crit Care Med 1999;160(2):736-755.

16. Bresnitz EA, Strom BL. Epidemiology of sarcoidosis. Epidemiol Rev. 1983;5:124-56.

17. Cummings MM, Dunner E, Williams JH Jr. Epidemiologic and clinical observations in sarcoidosis. Ann Intern Med. 1959;50:879-90.

18. Cummings MM, Dunner E, Schmidt H Jr, Barnwell JB. Concepts of epidemiology of sarcoidosis. Postgrad Med. 1956;19:437-46.

19. Henke CE, Henke G, Elveback LR, Beard CM, Ballard DJ, Kurland LT. The epidemiology of sarcoidosis in Rochester, Minnesota: a population-based study of incidence and survival. Am J Epidemiol 1986; 123: 840-45.

20. James DG. Epidemiology of sarcoidosis. Sarcoidosis. 1992;9:79-87.

21. Rybicki BA, Major M, Popovich J Jr, Maliarik MJ, Iannuzzi MC. Racial differences in sarcoidosis incidence: a 5-year study in a health maintenance organization. Am J Epidemiol. 1997;145:234-41.

22. Sartwell PE, Edwards LB. Epidemiology of sarcoidosis in the US Navy. Am J Epidemiol. 1974;99:250-7.

23. Cooch JW. Sarcoidosis in the U.S. Army, 1952 through 1956. Am Rev Respir Dis. 1961;84 (Suppl):103-8.

24. Gundelfinger BF, Britten SA. Sarcoidosis in the U.S. Navy. Am Rev Respir Dis. 1961;84 (Suppl):109-15.

25. Israel HL. Influence of race and geographical origin on sarcoidosis. Arch Environ Health. 1970;20:608-10.

26. Siltzbach LE. Geographic aspects of sarcoidosis. Trans N Y Acad Sci. 1967;29:364-74.

27. Badrinas F. Morera J, Fite E, Plasencia A. Seasonal clustering of sarcoidosis. Lancet. 1989;ii:455-6.

28. Gentry JT, Nitowsky HM, Michael M Jr. Studies on the epidemiology of sarcoidosis in the United States: the relationship to soil areas and to urban/rural residence. J Clin Invest. 1955;34:1839-56.

29. Hennessy TW, Ballard DJ, DeRemee RA, Chu CP, Melton LJ. The influence of diagnostic access bias on the epidemiology of sarcoidosis: a population-based study in Rochester, Minnesota, 1935-1984. J Clin Epidemiol. 1988;41:565-70.

30. Redline S, Barna BP, Tomashefski JF, Jr, Abraham JL. Granulomatous disease associated with pulmonary deposition of titanium. Br J Indian Med 1986;43:652-656.

31. DeVuyst P, Dumortier P, Schandene L, Estenne M, Verhest A, Yernault JC. Sarcoidlike lung granulomatosis induced by aluminum dusts. Am Rev Respir Dis 1987;135:493-497.

32. Hull MJ, Abraham JL. Aluminum welding fume-induced pneumoconiosis. Hum Pathol 2002 Aug;33(8):819-25

33. Skelton HGD, Smith KJ, Johnson FB, Cooper CR, Tyler WF, Lupton GP. Zirconium granuloma resulting from an aluminum zirconium complex: a previously unrecognized agent in the development of hypersensitivity granulomas. J Am Acad Dermatol 1993;28:874-876.

34. Kim YC, Triffet MK, Gibson LE. Foreign bodies in sarcoidosis. Am J Dermatopathol. 2000; 22:408-12.

35. Drent M, Bomans PH, Van Suylen RJ, Lamers RJ, Bast A, Wouters EF. Association of man-made mineral fibre exposure and sarcoidlike granulomas. Respir Med. 2000;94:815-20.

36. Rafnsson V, Ingimarsson O, Hjalmarsson I, Gunnarsdottir H. Association between exposure to crystalline silica and risk of sarcoidosis. Occup Environ Med. 1998;55:657-60.

37. Abraham JL, Panitz EB. Is sarcoidosis in the US Navy occupational lung disease from the grinding of non-skid paint aboard aircraft carriers? Analysis of inorganic particulates in lungs and a reference paint sample. Am J Respir Crit Care Med; 163(5)(Abstract Issue):A214.

38. International Classification of Diseases, Ninth Revision, Clinical Modification, sixth edition. Salt Lake City: Medicode, 2000.

39. Gunderson EKE, Miller MR, Garland CF. Career History Archival Medical and Personnel System (CHAMPS): Data resource for cancer, chronic disease, and other epidemiological research. Naval Health Research Center Technical Report No. 02-06. San Diego: Naval Health Research Center, 2002.

40. Kajdasz, DK, Lackland DT, Mohr LC, Judson MA. A current assessment of rurally linked exposures as potential risk factors for sarcoidosis. Ann Epidemiol. 2001;11:111-7.

41. Kajdasz DK, Judson MA, Mohr LC, Lackland DT. Geographic variation in sarcoidosis in South Carolina: its relation to socioeconomic status and health care indicators. Am J Epidemiol. 1999;150:271-8.

42. Newman LS, Kreiss K, King TE, Seay S, Campbell PA. Pathologic and immunologic alterations in early stages of beryllium disease: re-examination of disease definition and natural history. Am Rev Respir Dis. 1989;139:1479-86.

43. Armbruster C, Dekan G, Hovorka A. Granulomatous pneumonitis and mediastinal lymphadenopathy due to photocopier toner dust. Lancet. 1996;348:690.

44. Pimentel JC. Systemic granulomatous disease, of the sarcoid type, caused by inhalation of titanium dioxide. Anatomo-clinical and experimental study. Acta Med Port. 1992;5:307-13.

45. Kotter JM, Zieger G. Sarcoid granulomatosis after many years of exposure to zirconium, "zirconium lung." Pathologe. 1992;13:104-9.

46. McDonough C, Gray GC. Risk factors for sarcoidosis hospitalization among U.S. Navy and Marine Corps personnel, 1981 to 1995. Mil Med. 2000;165:630-2.

47. Pesola GR, Kurdi M, Olibrice M. Endobronchial sarcoidosis and hyperreactive airways disease. Chest. 2002;121:2081.

48. Connolly JP, Baez SA. Asthma in the Navy and Marine Corps. Mil Med. 1991;156:461-5.

49. Gunderson EKE, Garland CF. Health surveillance of asthma in the US Navy: Experience of 4,809,422 person-years. Naval Health Research Center Technical Report No. 02-09. San Diego: Naval Health Research Center, 2002.

Table 2. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted men, 1965-2001

	Sarcoidosis cases		Controls				95% Confidence interval	
Age (years)	No.	%	No.	%	*p*-value	Odds ratio	Lower limit	Upper limit
17-19	43	3.7	8,662	7.9	<0.0001	0.45	0.32	0.61
20-24	467	40.2	61,284	56.2	<0.0001	0.52	0.48	0.57
25-29	316	27.2	19,365	17.8	<0.0001	1.73	1.54	1.94
30-34	166	14.3	5,793	5.3	<0.0001	2.97	2.54	3.48
35-39	118	10.2	6,532	6.0	<0.0001	1.77	1.48	2.13
40-44	43	3.7	5,093	4.7	0.12	0.78	0.56	1.07
45-64	9	0.8	2,297	2.1	<0.01	0.36	0.17	0.69
Unknown	0	0.0	11	0.0	0.73	0.00	-	-
Total	1,162	100.0	109,037	100.0	<0.0001	-	-	-
Mean	27.1		25.3					
Standard Deviation	6.2		6.6					
Race								
White	582	50.1	92984	85.3	<0.0001	0.17	0.16	0.19
Black	561	48.3	11,852	10.9	<0.0001	7.65	7.00	8.37
Other	19	1.6	4,201	3.9	<0.0001	0.41	0.25	0.65
Unknown	-	-	-	-	-	-	-	-
Total	1162	100.0	109,037	100.0	<0.0001	-	-	-
Length of service (years)								
0 - 1.9	215	18.5	20,705	19.0	0.67	0.97	0.84	1.11
2 - 3.9	274	23.6	27,664	25.4	0.16	0.91	0.80	1.03
4 - 5.9	156	13.4	31,649	29.0	<0.0001	0.38	0.32	0.44
6 +	517	44.5	29,019	26.6	<0.0001	2.21	2.02	2.42
Unknown	-	-	-	-	-	-	-	-
Total	1,162	100.0	109,037	100.0	<0.0001	-	-	-
Paygrade								
E1-E3	255	21.9	26,505	24.3	0.06	0.88	0.77	0.99
E4-5	408	35.1	26,799	24.6	<0.0001	1.66	1.50	1.83
E6+	499	42.9	12,036	11.0	<0.0001	6.07	5.55	6.63
Unknown	0	0.0	43,697	40.1	<0.0001	0.00	0.00	0.00
Total	1,162	100.0	109,037	100.0	<0.0001	-	-	-

Table 2. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted men, 1965-2001 (continued)

Aircraft carrier assignment history:*								
Ever	221	19.0	10,898	10.0	<0.0001	2.11	1.84	2.43
Never	941	81.0	98,139	90.0	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Total	1,162	100.0	109,037	100.0	-	-	-	-
Date of entry to Navy								
Before 1965	275	23.7	16,958	15.6	<0.0001	1.68	1.48	1.91
1965 - 1974	436	37.5	38,358	35.2	0.10	1.11	1.00	1.22
1975 - 1981	257	22.1	18,099	16.6	<0.0001	1.43	1.26	1.62
1982 - 1987	138	11.9	13,691	12.6	0.49	0.94	0.79	1.11
1988 - 1993	42	3.6	11,727	10.8	<0.0001	0.31	0.22	0.42
1994 - 2001	14	1.2	9,952	9.1	<0.0001	0.12	0.07	0.20
Unknown	0	0.0	252	0.2	0.1009	0.00	0.00	0.00
Total	1,162	100.0	109,037	100.0	<.0001	-	-	-
Age at entry to Navy								
17 - 19	602	51.8	63,795	58.5	<0.0001	0.76	0.70	0.83
20 - 24	475	40.9	39,934	36.6	<0.01	1.20	1.09	1.31
25 - 29	61	5.3	3,853	3.5	<0.01	1.51	1.16	1.97
30 - 34	18	1.6	1,040	1.0	<0.05	1.63	0.97	2.58
35 - 39	5	0.4	203	0.2	0.06	2.32	0.75	5.40
40 - 44	1	0.1	86	0.1	0.93	1.09	0.03	6.08
45 - 64	0	0.0	110	0.1	0.28	0.00	0.00	0.00
Unknown	0	0.0	16	0.0	0.68	0.00	0.00	0.00
Total	1,162	100.0	109,037	100.0	<.0001	-	-	-
Home of record								
Southeast	455	39.2	18,425	16.9	<0.0001	3.16	2.88	3.48
Northeast	213	18.3	18,942	17.4	0.39	1.07	0.93	1.23
Midwest	195	16.8	24,939	22.9	<0.0001	0.68	0.59	0.78
South Central	101	8.7	9,507	8.7	0.97	1.00	0.82	1.22
Mountain	16	1.4	4,436	4.1	<0.0001	0.33	0.19	0.53
Pacific	71	6.1	13,837	12.7	<0.0001	0.45	0.35	0.57
Other	5	0.4	517	0.5	0.83	0.91	0.29	2.11
Unknown	106	9.1	18,434	16.9	<0.0001	0.49	0.40	0.60
Total	1,162	100.0	109,037	100.0	<0.0001	-	-	-

Table 3. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted white men, 1965-2001

	Sarcoidosis cases		Controls				95% Confidence interval	
Age (years)	No.	%	No.	%	*p*-value	Odds ratio	Lower limit	Upper limit
17-19	17	2.9	7,335	7.9	<0.0001	0.35	0.22	0.57
20-24	236	40.6	53,535	57.6	<0.0001	0.50	0.43	0.59
25-29	148	25.4	16,345	17.6	<0.0001	1.60	1.33	1.93
30-34	75	12.9	4,524	4.9	<0.0001	2.89	2.27	3.69
35-39	77	13.2	5,468	5.9	<0.0001	2.44	1.92	3.11
40-44	23	4.0	4,002	4.3	0.68	0.91	0.60	1.39
45-64	6	1.0	1,768	1.9	0.12	0.54	0.24	1.20
Unknown	0	0.0	7	0.0	0.83	-	-	-
Total	582	100.0	92,984	100.0	<0.0001	-	-	-
Mean	27.44		25.30					
Standard Deviation	6.5		6.6					
Length of service (years)								
0 - 1.9	101	17.4	16,990	18.3	0.57	0.94	0.76	1.16
2 - 3.9	136	23.4	23,843	25.6	0.21	0.88	0.73	1.07
4 - 5.9	77	13.2	28,270	30.4	<0.0001	0.35	0.27	0.44
6 +	268	46.1	23,881	25.7	<0.0001	2.47	2.10	2.91
Unknown	-	-	-	-	-	-	-	-
Total	582	100.0	92,984	100.0	<0.0001	-	-	-
Paygrade								
E1-E3	97	16.7	20,686	22.3	0.0012	0.70	0.56	0.87
E4-5	194	33.3	22,488	24.2	<0.0001	1.57	1.32	1.86
E6+	291	50.0	10,099	10.9	<0.0001	8.21	6.97	9.67
Unknown	0	0.0	39,711	42.7	<0.0001	-	-	-
Total	582	100.0	92,984	100.0	<0.0001	-	-	-
Aircraft carrier assignment history:*								
Ever	78	86.6	8,414	9.1	0.0003	-	-	-
Never	504	13.4	84,570	91.0	0.0003	-	-	-
Unknown	-	-	-	-	-	-	-	-
Total	582	100.0	92,984	100.0	0.0003	1.56	1.22	1.98

Table 3. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted white men, 1965-2001 (continued)

Date of entry to Navy								
Before 1965	155	26.6	15,499	16.67	<0.0001	1.81	1.51	2.18
1965 - 1974	262	45.0	34,975	37.61	0.0002	1.36	1.15	1.60
1975 - 1981	93	16.0	15,239	16.39	0.79	0.97	0.78	1.21
1982 - 1987	51	8.8	11,030	11.86	0.02	0.71	0.54	0.95
1988 - 1993	17	2.9	8,992	9.67	<0.0001	0.28	0.17	0.46
1994 - 2001	4	0.7	7,065	7.60	<0.0001	0.08	0.03	0.23
Unknown	0	0.0	184	0.20	0.28	-	-	-
Total	582	100.0	92,984	100.00	<0.0001	-	-	-
Age at entry to Navy								
17 - 19	321	55.2	55,581	59.8	0.02	0.83	0.70	0.98
20 - 24	221	38.0	33,439	36.0	0.31	1.09	0.92	1.29
25 - 29	24	4.1	2,850	3.1	0.14	1.36	0.90	2.05
30 - 34	10	1.7	751	0.8	0.01	2.15	1.14	4.03
35 - 39	5	0.9	171	0.2	0.00	4.70	1.93	11.49
40 - 44	1	0.2	81	0.1	0.49	1.97	0.27	14.21
45 - 64	0	0.0	100	0.1	0.43	-	-	-
Unknown	0	0.0	11	0.0	0.79	-	-	-
Total	582	100.0	92,984	100.0	0.00	-	-	-
Home of record								
Southeast	152	26.1	13,871	14.9	<0.0001	2.02	1.67	2.43
Northeast	142	24.4	16,441	17.7	<0.0001	1.50	1.24	1.82
Midwest	130	22.3	22,445	24.1	0.31	0.90	0.74	1.10
South Central	37	6.4	7,674	8.3	0.10	0.75	0.54	1.05
Mountain	11	1.9	4,143	4.5	0.00	0.41	0.23	0.75
Pacific	49	8.4	11,041	11.9	0.01	0.68	0.51	0.91
Other	3	0.5	198	0.2	0.12	2.43	0.77	7.62
Unknown	58	10.0	17,171	18.0	<0.0001	0.49	0.37	0.64
Total	582	100.0	92,984	100.0	<0.0001	-	-	-

* Includes CV, CVN, CVA, CVAN, and CVS aircraft carriers except USS LEXINGTON (CVS16), whose crew members could not be identified through UIC or PAMI codes. This ship was decommissioned in 1991.

Table 4. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted black men, 1965-2001

	Sarcoidosis cases		Controls				95% Confidence interval	
Age (years)	No.	%	No.	%	*p*-value	Odds ratio	Lower limit	Upper limit
17-19	26	4.6	1,062	9.0	<0.0001	0.49	0.33	0.74
20-24	228	40.6	6,198	52.3	<0.0001	0.62	0.53	0.74
25-29	164	29.2	2,295	19.4	<0.0001	1.72	1.43	2.08
30-34	85	15.2	897	7.6	<0.0001	2.18	1.71	2.77
35-39	38	6.8	738	6.2	0.60	1.09	0.78	1.53
40-44	17	3.0	481	4.1	0.23	0.74	0.45	1.21
45-64	3	0.5	180	1.5	0.06	0.35	0.11	1.09
Unknown	0	0.0	1	0.0	0.83	0.00	-	-
Total	561	100.0	11,852	100.0	<0.0001	-	-	-
Mean	26.5		25.4					
Standard Deviation	5.8		6.5					
Length of service (years)								
0 - 1.9	114	20.3	2,837	23.9	<0.05	0.81	0.66	1.00
2 - 3.9	136	24.2	3,134	26.4	0.24	0.89	0.73	1.08
4 - 5.9	76	13.5	2,589	21.8	<0.0001	0.56	0.44	0.72
6 +	235	41.9	3,292	27.8	<0.0001	1.87	1.58	2.23
Unknown	-	-	-	-	-	-	-	-
Total	561	100.0	11,852	100.0	<0.0001	-	-	-
Pay grade								
E1-E3	156	27.8	4,654	39.3	<0.0001	0.60	0.49	0.72
E4-5	210	37.4	3,030	25.6	<0.0001	1.74	1.46	2.08
E6+	195	34.8	992	8.4	<0.0001	5.83	4.85	7.02
Unknown	0	0.0	3,176	26.8	<0.0001	0.00	-	-
Total	561	100.0	11,852	100.0	<0.0001	-	-	-

Table 4. Demographic and service characteristics of sarcoidosis cases and controls, active-duty Navy enlisted black men, 1965-2001(continued).

Aircraft carrier assignment history:*								
Ever	139	24.8	1,775	15.0	<0.0001	1.87	1.53	2.28
Never	422	75.2	10,077	85.0	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Total	561	100.0	11,852	100.0	-	-	-	-
Date of entry to Navy								
Before 1965	112	23.7	933	7.87	<0.0001	2.92	2.35	3.63
1965 - 1974	170	37.5	2,689	22.69	<0.0001	1.48	1.23	1.78
1975 - 1981	159	22.1	2,182	18.41	<0.0001	1.75	1.45	2.12
1982 - 1987	85	11.9	1,982	16.72	0.33	0.89	0.70	1.13
1988 - 1993	25	3.6	2,226	18.78	<0.0001	0.20	0.13	0.30
1994 - 2001	10	1.2	1,801	15.20	<0.0001	0.10	0.05	0.19
Unknown	0	0.0	39	0.33	0.17	0.00	-	-
Total	561	100.0	11,852	100.00	<0.0001	-	-	-
Age at entry to Navy								
17 - 19	274	48.8	6,551	55.3	<0.01	0.77	0.65	0.92
20 - 24	243	43.3	4,529	38.2	<0.05	1.24	1.04	1.47
25 - 29	36	6.4	589	5.0	0.13	1.31	0.93	1.86
30 - 34	8	1.4	157	1.3	0.84	1.08	0.53	2.20
35 - 39	0	0.0	17	0.1	0.37	0.00	-	-
40 - 44	0	0.0	4	0.0	0.66	0.00	-	-
45 - 64	0	0.0	3	0.0	0.71	0.00	-	-
Unknown	0	0.0	2	0.0	0.76	0.00	-	-
Total	561	100.0	11,852	100.0	0.13	-	-	-
Home of record								
Southeast	300	53.5	4,265	36.0	<0.0001	2.04	1.72	2.42
Northeast	67	11.9	2,028	17.1	≤0.001	0.66	0.51	0.85
Midwest	64	11.4	2,185	18.4	<0.0001	0.57	0.44	0.74
South Central	64	11.4	1,538	13.0	0.28	0.86	0.66	1.13
Mountain	5	0.9	94	0.8	0.80	1.12	0.46	2.78
Pacific	13	2.3	706	6.0	<0.001	0.37	0.22	0.65
Other	1	0.2	62	0.5	0.26	0.34	0.05	2.45
Unknown	47	8.4	974	8.2	0.89	1.02	0.75	1.39
Total	561	100.0	11,852	100.0	<0.0001	-	-	-

* Includes CV, CVN, CVA, CVAN, and CVS aircraft carriers except USS LEXINGTON (CVS16), whose crew members could not be identified through UIC or PAMI codes. This ship was decommissioned in 1991.

Table 5. Odds ratios for sarcoidosis by occupation and history of assignment to an aircraft carier, active-duty Navy enlisted white men, 1965-2000

	Aircraft Carrier Assignment History												
	Ever					95% Confidence interval		Never					95% Confidence interval
	Cases		Controls		Odds			Cases		Controls		Odds	
Occupation	No.	%	No.	%	ratio	Lower	Upper	No.	%	No.	%	ratio	Lower	Upper
Aviation ratings													
ABE Aviation Boatswain's Mate - Launch	1	1.3	246	2.9	0.43	0.06	3.11	0	0.0	48	0.1	0.00	-	-
ABF Aviation Boatswain's Mate - Fuels	1	1.3	167	2.0	0.64	0.09	4.64	0	0.0	88	0.1	0.00	-	-
ABH Av. Boatswain's Mate - Aircraft Handling	2	2.6	282	3.4	0.76	0.19	3.11	1	0.2	155	0.2	1.08	0.15	7.75
AC Air Traffic Controller	3	3.8	93	1.1	3.58	1.11	11.55	1	0.2	161	0.2	1.04	0.15	7.46
AD Aviation Mach. Mate	4	5.1	65	0.8	6.94	2.47	19.55	9	1.8	945	1.1	1.60	0.83	3.12
AE Aviation Electrician	1	1.3	65	0.8	1.67	0.23	12.18	10	2.0	846	1.0	1.98	1.07	3.76
AF Aircraft Maintenance Tech	1	1.3	2	0.0	54.62	4.90	608.73	2	0.4	40	0.0	8.39	2.03	34.93
AM Aviation Structural Mechanic	0	0.0	21	0.2	0.00	-	-	4	0.8	226	0.3	2.97	1.11	8.06
AME Aviation Structural Mechanic-Safety	0	0.0	6	0.1	0.00	-	-	3	0.6	290	0.3	1.73	0.56	5.45
AMH Aviation Structural Mechanic-Hydraulics	0	0.0	32	0.4	0.00	-	-	6	1.2	526	0.6	1.91	0.86	4.33
AMS Aviation Structual Mechanic-Structures	2	2.6	44	0.5	5.01	1.19	21.02	7	1.4	692	0.8	1.70	0.81	3.61
AN Airman	0	0.0	820	9.7	0.00	-	-	14	2.8	1,819	2.2	1.29	0.76	2.22
AO Aviation Ordinanceman	1	1.3	352	4.2	0.30	0.04	2.14	6	1.2	467	0.6	2.15	0.97	4.88
AQ Aviation Fire Control Technician	1	1.3	30	0.4	3.63	0.49	26.95	3	0.6	197	0.2	2.55	0.82	8.05
AS Aviation Support Equipment Technician	0	0.0	77	0.9	0.00	-	-	1	0.2	92	0.1	1.82	0.25	13.12
ASE Aviation Support Equipment Technician-Electrical	0	0.0	19	0.2	0.00	-	-	0	0.0	32	0.0	0.00	-	-
ASH Aviation Support Equipment Technician-Hydraulics	0	0.0	6	0.1	0.00	-	-	0	0.0	12	0.0	0.00	-	-
ASM Aviation Support Equipment Technician-Mechanical	0	0.0	34	0.4	0.00	-	-	0	0.0	64	0.1	0.00	-	-
AT Aviation Electronics Technician	6	7.7	205	2.4	3.34	1.43	7.76	8	1.6	1,308	1.5	1.02	0.51	2.07
Other Aviation Occupations	3	3.8	334	4.0	0.97	0.30	3.08	18	3.6	1,356	1.6	2.23	1.42	3.65
Non-aviation ratings														
BM Boatswain's Mate	4	5.1	184	2.2	2.42	0.87	6.68	7	1.4	1,140	1.3	1.03	0.49	2.18
BT Boiler technician	3	3.8	250	3.0	1.31	0.41	4.17	8	1.6	969	1.1	1.38	0.69	2.81
DK Disbursing Clerk	0	0.0	33	0.4	0.00	-	-	2	0.4	127	0.2	2.64	0.65	10.74
EM Electrician's Mate	8	10.3	319	3.8	2.90	1.38	6.08	11	2.2	1,216	1.4	1.52	0.84	2.79
FN Fireman	0	0.0	432	5.1	0.00	-	-	10	2.0	2,355	2.8	0.71	0.38	1.32
GS Gas Turbine System Technician	0	0.0	4	0.0	0.00	-	-	4	0.8	26	0.0	25.82	9.05	74.81
HM Hospitalman	4	5.1	225	2.7	1.97	0.71	5.43	40	7.9	2,250	2.7	2.98	2.28	4.37
MM Machinist's Mate	5	6.4	747	8.9	0.70	0.28	1.75	36	7.1	2,710	3.2	2.23	1.65	3.27
MS Mess Management Specialist	4	5.1	228	2.7	1.94	0.70	5.35	11	2.2	1,005	1.2	1.83	1.02	3.38
SH Ship's Serviceman	1	1.3	89	1.1	1.21	0.17	8.83	4	0.8	295	0.3	2.27	0.85	6.15
SN Seaman	1	1.3	475	5.6	0.22	0.03	1.56	33	6.5	5,980	7.1	0.92	0.65	1.31
Other occupations	22	28.2	2,528	30.0	0.91	0.56	1.50	245	48.6	57,133	67.6	0.72	0.38	0.54
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	78	100.0	8,414	100.0	-	-	-	504	100.0	84,570	100.0	-	-	-

Table 6. Odds ratios for sarcoidosis by occupation and history of assignment to an aircraft carier, active-duty Navy enlisted black men, 1965-2000

	Aircraft Carrier Assignment History													
	Ever							Never						
	Cases		Controls		Odds	95% Confidence interval		Cases		Controls		Odds	95% Confidence interval	
Occupation	No.	%	No.	%	ratio	Lower	Upper	No.	%	No.	%	ratio	Lower	Upper
Aviation ratings														
ABE Aviation Boatswain's Mate - Launch	3	2.2	49	2.8	0.78	0.24	2.53	0	0.0	5	0.0	0.00	-	-
ABF Aviation Boatswain's Mate - Fuels	2	1.4	40	2.3	0.63	0.15	2.65	0	0.0	21	0.2	0.00	-	-
ABH Av. Boatswain's Mate - Aircraft Handling	2	1.4	70	3.9	0.36	0.09	1.47	0	0.0	29	0.3	0.00	-	-
AC Air Traffic Controller	0	0.0	15	0.8	0.00	-	-	1	0.2	24	0.2	0.99	0.13	7.37
AD Aviation Mach. Mate	0	0.0	18	1.0	0.00	-	-	5	1.2	115	1.1	1.04	0.42	2.56
AE Aviation Electrician	1	0.7	13	0.7	0.98	0.13	7.56	6	1.4	108	1.1	1.32	0.58	3.05
AF Aircraft Maintenance Tech	0	0.0	1	0.1	0.00	-	-	1	0.2	4	0.0	5.97	0.67	53.63
AM Aviation Structural Mechanic	0	0.0	5	0.3	0.00	-	-	5	1.2	17	0.2	7.03	2.61	19.32
AME Aviation Structural Mechanic-Safety	0	0.0	0	0.0	-	-	-	3	0.7	23	0.2	3.11	0.94	10.47
AMH Aviation Structural Mechanic-Hydraulics	1	0.7	8	0.5	1.60	0.20	12.89	3	0.7	43	0.4	1.66	0.52	5.41
AMS Aviation Structual Mechanic-Structures	3	2.2	5	0.3	7.81	1.85	33.02	11	2.6	66	0.7	3.98	2.13	7.74
AN Airman	6	4.3	193	10.9	0.37	0.16	0.85	19	4.5	426	4.2	1.06	0.67	1.71
AO Aviation Ordinanceman	6	4.3	72	4.1	1.07	0.46	2.50	6	1.4	81	0.8	1.77	0.77	4.10
AQ Aviation Fire Control Technician	0	0.0	1	0.1	0.00	-	-	2	0.5	4	0.0	11.95	2.19	65.65
AS Aviation Support Equipment Technician	1	0.7	15	0.8	0.85	0.11	6.48	0	0.0	18	0.2	0.00	-	-
ASE Aviation Support Equipment Technician-Electrical	0	0.0	1	0.1	0.00	-	-	0	0.0	2	0.0	0.00	-	-
ASH Aviation Support Equipment Technician-Hydraulics	0	0.0	0	0.0	-	-	-	0	0.0	0	0.0	-	-	-
ASM Aviation Support Equipment Technician-Mechanical	0	0.0	5	0.3	0.00	-	-	0	0.0	1	0.0	-	-	-
AT Aviation Electronics Technician	3	2.2	12	0.7	3.24	0.90	11.62	1	0.2	84	0.8	0.28	0.04	2.03
Other Aviation Occupations	9	6.5	81	4.6	1.45	0.71	2.95	13	3.1	174	1.7	1.78	1.02	3.21
Non-aviation ratings														
BM Boatswain's Mate	7	5.0	52	2.9	1.76	0.78	3.94	9	2.1	253	2.5	0.85	0.43	1.66
BT Boiler technician	3	2.2	32	1.8	1.20	0.36	3.97	9	2.1	91	0.9	2.36	1.20	4.78
DK Disbursing Clerk	1	0.7	11	0.6	1.16	0.15	9.07	5	1.2	41	0.4	2.91	1.15	7.47
EM Electrician's Mate	4	2.9	54	3.0	0.94	0.34	2.65	6	1.4	148	1.5	0.97	0.43	2.20
FN Fireman	1	0.7	103	5.8	0.12	0.02	0.85	17	4.0	447	4.4	0.91	0.55	1.48
GS Gas Turbine System Technician	0	0.0	0	0.0	-	-	-	0	0.0	3	0.0	0.00	-	-
HM Hospitalman	7	5.0	38	2.1	2.42	1.06	5.53	38	9.0	384	3.8	2.36	1.76	3.54
MM Machinist's Mate	9	6.5	81	4.6	1.45	0.71	2.95	16	3.8	210	2.1	1.82	1.10	3.11
MS Mess Management Specialist	8	5.8	111	6.3	0.92	0.44	1.92	15	3.6	322	3.2	1.11	0.66	1.89
SH Ship's Serviceman	11	7.9	52	2.9	2.85	1.45	5.59	21	5.0	164	1.6	3.06	1.99	5.04
SN Seaman	4	2.9	156	8.8	0.31	0.11	0.84	54	12.8	1,565	15.5	0.82	0.60	1.07
Other occupations	47	33.8	481	27.1	1.37	0.95	1.98	156	37.0	5,204	51.6	0.71	0.45	0.67
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	139	100.0	1,775	100.0	-	-	-	422	100.0	10,077	100.0	-	-	-

Table 7. Multivariate analysis of risk factors for sarcoidosis, active-duty Navy enlisted men, 1965-2001

Covariate	No. of cases	No. of controls	Regression coefficient	S.E.*	*p* - value	Odds ratio	95% Confidence interval Lower	Upper
Age (years)								
17-19	43	8,662	-1.012	0.16	<0.001	0.36	0.27	0.50
20-24	467	61,284	-0.644	0.06	<0.001	0.53	0.46	0.59
25+	652	39,091	Reference	-	-	1.00	-	-
Total	1,162	109,037	-	-	-	-	-	-
Race								
White	582	92,984	Reference	-	-	1.00	-	-
Black	561	11,852	2.054	0.06	<0.001	7.80	6.87	8.85
Other	19	4,201	-0.085	0.24	0.73	0.92	0.57	1.48
	1,162	109,037	-	-	-	-	-	-
Entry Date								
Before 1975	698	55,316	Reference	-	-	1.00	-	-
1975-1984	342	24,586	-0.426	0.07	<0.001	0.65	0.57	0.75
1985-1994	108	20,262	-1.549	0.11	<0.001	0.21	0.17	0.26
1995-2001	14	8,873	-2.703	0.29	<0.001	0.07	0.04	0.12
	1,162	109,037	-	-	-	-	-	-
Rating†								
Seaman	92	8,521	0.168	0.12	0.15	1.18	0.94	1.49
Airman	39	3,458	0.318	0.17	0.06	1.38	0.98	1.92
Fireman	28	3,488	0.009	0.20	0.96	1.01	0.68	1.49
Aviation Boats. Mate	12	1,287	-0.633	0.30	<0.05	0.53	0.29	0.96
Other aviation ratings	177	9,887	0.548	0.09	<0.001	1.73	1.46	2.05
Mess Manag. Spec.	40	2,027	0.296	0.17	0.08	1.34	0.96	1.88
Ship's Serviceman	37	681	0.831	0.18	<0.001	2.30	1.60	3.29
All Other Ratings	737	79,688	Reference	-	-	1.00	-	-
Total	1,162	109,037	-	-	-	-	-	-
Aircraft carrier history								
Ever	221	10,898	0.593	0.08	<0.001	1.81	1.55	2.12
Never	941	98,139	Reference	-		-	-	-
Total	1,162	109,037	-	-	-	-	-	-

Table 7. Multivariate analysis of risk factors for sarcoidosis, active-duty Navy enlisted men, 1965-2001 (continued)

Covariate	No. of cases	No. of controls	Regression coefficient	S.E.	*p* - value	Odds ratio	95% Confidence interval Lower	Upper
Home of record								
Northeast	213	18,942	Reference	-	-	1.00	-	-
Southeast	455	18,425	0.692	0.08	<0.001	2.00	1.72	2.32
Midwest	195	24,939	-0.003	0.09	0.97	1.00	0.83	1.19
South Central	101	9,507	0.088	0.12	0.45	1.09	0.87	1.37
Pacific	71	13,837	-0.226	0.14	0.09	0.80	0.61	1.04
Mountain‡	16	4,436	-	-	-	-	-	-
Other‡	5	517	-	-	-	-	-	-
Unknown‡	106	18,434	-	-	-	-	-	-
Total	1,162	109,037	-	-	-	-	-	-

*S.E., Standard Error

†Model was obtained separately for each rating.

‡Not included in regression due to small sample size.

10 DEC 2002 3:50 PM Ver Rev 12/10/2002

Table 8. Multivariate analysis of risk factors for sarcoidosis, active-duty Navy enlisted white men, 1965-2001

Covariate	No. of cases	No. of control	Regression coefficient	S.E.†	*p* - value	Odds ratio	95% Confidence interval Lower	Upper
Age (years)								
17-19	17	7,335	-1.282	0.25	<0.0001	0.28	0.17	0.45
20-24	236	53,535	-0.788	0.09	<0.0001	0.45	0.38	0.54
25+	329	32,114	Reference	-	-	1.00	-	-
Total	582	92,984	-	-	-	-	-	-
Entry date								
Before 1975	412	52,925	Reference	-	-	1.00	-	-
1975-1984	131	18,105	-0.498	0.11	<0.0001	0.61	0.49	0.75
1985-1994	39	15,769	-1.354	0.17	<0.0001	0.26	0.19	0.36
1995-2001	3	6,185	-3.145	0.71	<0.0001	0.04	0.01	0.17
	582	92,984						
Rating								
Seaman	34	6,455	0.490	0.19	<0.01	1.63	1.13	2.35
Airman	14	2,639	0.463	0.28	0.10	1.59	0.92	2.75
Fireman	10	2,787	0.031	0.32	0.92	1.03	0.55	1.95
Aviat. Boats. Mate	5	1,003	-0.326	0.46	0.48	0.72	0.29	1.78
Other aviation ratings	94	8,358	0.600	0.12	<0.0001	1.82	1.45	2.30
Mess Manag. Spec.	15	1,233	0.759	0.27	<0.01	2.14	1.27	3.60
Ship's Serviceman	5	384	0.620	0.46	0.17	1.86	0.76	4.54
All other ratings	405	70,125	Reference	-	-	1.00	-	-
Total	582	92,984						
Aircraft carrier history								
Ever	78	8,414	0.511	0.13	<0.001	1.66	1.30	2.13
Never	504	84,570	Reference	-	-	-	-	-
Total	582	92,984	-	-	-	-	-	-
Home of record								
Northeast	142	16,441	Reference	-	-	1.00	-	-
Southeast	152	13,871	0.703	0.11	<0.001	2.02	1.63	2.50
Midwest	130	22,445	0.103	0.11	0.36	1.11	0.89	1.38
South Central	37	7,674	-0.021	0.18	0.91	0.98	0.69	1.39
Pacific	49	11,041	-0.115	0.16	0.47	0.89	0.65	1.22
Mountain†	11	4,143	-	-	-	-	-	-
Other†	3	198	-	-	-	-	-	-
Unknown†	58	17,171	-	-	-	-	-	-
Total	582	92,984	-	-	-	-	-	-

*S.E., Standard error

†Not included in regression due to small sample size.

Table 9. Multivariate analysis of risk factors for sarcoidosis, active-duty Navy enlisted black men, 1965-2001

Covariate	No. of cases	No. of controls	Regression coefficient	S.E.*	p - value	Odds ratio	95% Confidence interval Lower	Upper
Age (years)								
17-19	26	1,062	-0.729	0.21	< 0.001	0.48	0.32	0.73
20-24	228	6,198	-0.464	0.09	< 0.001	0.63	0.52	0.76
25+	307	4,592	Reference	-	-	1.00	-	-
Total	561	11,852	-	-	-	-	-	-
Entry date								
Before 1975	282	3,622	Reference	-	-	1.00	-	-
1975-1984	203	3,002	-0.337	0.10	<0.001	0.71	0.59	0.87
1985-1994	66	3,588	-1.614	0.14	< 0.0001	0.20	0.15	0.26
1995-2001	10	1,640	-2.542	0.32	<0.0001	0.08	0.04	0.15
	561	11,852	-	-	-	-	-	-
Rating								
Seaman	58	1,721	-0.013	0.15	0.93	0.99	0.74	1.32
Airman	25	619	0.237	0.22	0.28	1.27	0.83	1.94
Fireman	18	550	0.009	0.25	0.97	1.00	0.62	1.65
Aviat. Boats. Mate	7	216	-0.808	0.40	< 0.05	0.45	0.20	0.97
Other aviation ratings	77	1,007	0.428	0.13	< 0.01	1.53	1.18	1.99
Mess Manag. Spec.	23	433	0.163	0.23	0.47	1.18	0.76	1.83
Ship's Serviceman	32	216	0.926	0.20	< 0.001	2.52	1.69	3.76
All other ratings	321	7,090	Reference	-	-	1.00	-	-
Total	561	11,852	-	-	-	-	-	-
Aircraft carrier history								
Ever	139	10,077	0.683	0.11	<0.0001	1.98	1.60	2.44
Never	422	1,775	Reference	-	-	1.00	-	-
Total	561	11,852	-	-	-	-	-	-
Home of record								
Northeast	67	2,028	Reference	-	-	1.00	-	-
Southeast	300	4,265	0.647	0.11	<0.0001	1.91	1.53	2.38
Midwest	64	2,185	-0.212	0.16	0.18	0.81	0.59	1.11
South Central	64	1,538	0.141	0.16	0.38	1.15	0.84	1.58
Pacific	13	706	-0.503	0.30	0.09	0.60	0.34	1.08
Mountain†	5	94	-	-	-	-	-	-
Other†	1	62	-	-	-	-	-	-
Unknown†	47	974	-	-	-	-	-	-
Total	561	11,852	-	-	-	-	-	-

*S.E., Standard error

†Not included in regression due to small sample size.

Table 10. Multiple adjusted odds ratios for sarcoidosis (ICD-9 Code 135) among white and black Navy enlisted men by year of Navy Entry and year of change in Navy requirements for radiography associated with service entry, separation and tuberculosis skin test (TBSK) screening results, 1965-2001

Year of Entry	White			Black			Routine Chest Radiography Requirement				
	Odds Ratio	95% Confidence Interval		Odds Ratio	95% Confidence Interval		Policy Change (year)	At Entry	Annual TB Screening		At Separation
		Lower	Upper		Lower	Upper			TBSK+	TBSK-	
Before 1975	1.00	-	-	1.00	-	-	1975*	Yes	Yes	Yes	Yes
1975-1984	0.56	0.46	0.69	0.70	0.58	0.85	1976-86 #	Yes	No	Yes	Yes
1985-1994	0.24	0.17	0.33	0.19	0.15	0.26	1987-89 †	Yes	No	No	Yes
1995-2001	0.04	0.01	0.16	0.08	0.04	0.14	1990-2001	No	No	No	No

* August 1975--Navy Medicine "Tuberculosis Control Program" instruction eliminated the requirement for most routine annual chest radiographs.

October 1986--Navy Medicine "Tuberculosis Control Program" instruction eliminated the requirement for annual chest radiograph of known tuberculosis skin test reactors who remain asymptomatic.

† April 1989 --Navy Medicine message eliminated the requirement for chest radiograph as part of the tuberculosis control program upon entry to Naval service and for the separation physical.

REPORT DOCUMENTATION PAGE

1. Report Date (DD MM YY)	2. Report Type	3. DATES COVERED (from - to)
14 JAN 04	Final	1 JAN 01 - 31 DEC 03

4. TITLE AND SUBTITLE
Navy Lung Disease Assessment Program: Final Report

5a. Contract Number:
5b. Grant Number:
5c. Program Element:
5d. Project Number:
5e. Task Number:
5f. Work Unit Number: 60208

6. AUTHORS
F.C. Garland, Ph.D.; E.D. Gorham, Ph.D.; K.S. Kaiser, M.P.H.; W.D. Travis, M.D.; J.A. Centeno, Ph.D.; J.L. Abraham, M.D.; F. Hasibuan, M.P.H;

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Health Research Center
P.O. Box 85122
San Diego, CA 92186-5122

8. PERFORMING ORGANIZATION REPORT NUMBER
Report 04-06

8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Chief, Bureau of Medicine and Surgery
Code M2
2300 E St NW
Washington DC 20372-5300

10. Sponsor/Monitor's Acronyms(s)
BuMed

11. Sponsor/Monitor's Report Number(s)

12 DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT (maximum 200 words)
In response to Congressional concerns that occupational lung disease may have been misdiagnosed among Navy personnel exposed to dusts aboard ship, the Navy Bureau of Medicine and Surgery established the Navy Lung Disease Assessment Program and designated the Naval Health Research Center as the Program Manager. An External Scientific Advisory Board was established to define the study objectives. Two epidemiological studies of sarcoidosis and related lung diseases in active-duty Navy personnel were carried out to determine if sarcoidosis risk was related to particular occupations and demographic groups in the Navy. A review by pathologists of extant pathological tissue specimens with detailed mineral analysis was also recommended and carried out. There was a steep decline in incidence of hospitalizations for sarcoidosis since the early 1970s, particularly in blacks. There was no contemporaneous increase in incidence of other lung diseases in men of either race, such as pneumoconioses, asthma, or other lung disease that could account for the decline in sarcoidosis incidence. The decline in the incidence rates of sarcoidosis paralleled a decline in frequency of chest radiography. The cohort study found increased incidence rates of sarcoidosis in blacks and in some occupations. Black Ship's Servicemen had 2.3 times the expected incidence compared with all black personnel, and black Aviation Structural Mechanics specializing in structures had approximately twice the expected incidence. White Mess Management Specialists also had twice the expected incidence rate. Archived pathology specimens were obtained from 32 individuals, including 18 who had a diagnosis of sarcoidosis in a Navy hospital. Findings indicated possible associations between history of shipboard service and presence of particles in tissue, but conclusive results were limited by lack of tissue availability.

14. SUBJECT TERMS Sarcoidosis, epidemiology, military, pathology, scanning electron microscopy-energy dispersive x-ray spectrometry.

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	18a. NAME OF RESPONSIBLE PERSON
a. REPORT	b.ABSTRACT	b. THIS PAGE			Commanding Officer
UNCL	UNCL	UNCL	UNCL	196	18b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: (619) 553-8429